

TOPICS OF THE MONTH

New horizons for coal

THE advent of nuclear power as a practical possibility, the astonishing growth of oil-refining activities throughout the world and a number of other factors, including increasing costs in coal mining, have led to a number of false ideas about future energy resources. One idea—that nuclear energy will very shortly do away with the need for coal—has been emphatically swept away by prominent European industrialists and scientists, who have pointed out that in 20 or 30 years' time the cry from industry will still be for more coal, not less. Another idea—that petroleum must inevitably be coal's deadly rival in the race to supply industry's requirements—is equally wrong. There is no longer any room for rivalry between different fuels; the urgent need is to concentrate on a plan for extracting the maximum from all of them.

With coal, apart from the problems of improving methods of mining and bringing down production costs, there is the formidable but fascinating task of deciding on more efficient ways of utilising it. This includes steering a path between the conflicting claims and different aims of carbonisation, hydrogenation, some of the newer ideas in gasification (*e.g.* underground gasification), as well as a host of processes—such as the Fischer-Tropsch synthesis—which, although less immediately likely to become major uses, are nevertheless possible uses which cannot be ignored. Looking around the world, one is staggered at the number of projects which have already reached fruition, demonstrating the many different possibilities of coal as a raw material for the manufacture of both fuels and chemicals.

But in Europe, the more immediate problems are concerned with utilising the lower-rank coals for the manufacture of smokeless fuels. Here, chemical engineering can play an important part, as it has been shown by the development of the fluid-bed method of carbonisation. The chemical engineer has also the task of improving methods of obtaining chemical by-products from coal processing operations, and of realising the ambitions of the chemists who are constantly discovering in coal new chemicals for possible extraction.

In this issue of **CHEMICAL & PROCESS ENGINEERING** we include one or two articles which show some of the newer ideas about using coal and some of the newer contributions of chemical engineering to the processing of both coal and its by-products. While these by no means cover the whole of this vast field, we hope that they will do something towards focussing the picture a little and stimulating thoughts about the new approach to coal utilisation that must be evolved to meet the demands of a rapidly changing world.

Bringing down the prices

THERE is mounting evidence of the willingness of Britain's industries to tackle the current inflation problem and to halt the rise of prices wherever possible. One of the latest moves was a joint declaration by the Association of British Chambers of Commerce, the British Employers' Confederation, the Federation of British Industries and the National Union of Manufacturers that they were united in recommending a policy of price restraint which they outlined, concluding with the observation that the months immediately ahead will have to be 'devoted, with renewed vigour by all in industry, to the pursuit of higher productivity and administrative economies.'

Close upon this, the Association of British Chemical Manufacturers endorsed these recommendations, so showing that the chemical industry is as quick as ever to set a good example in the matter of price restraint, and giving the industries to which it supplies raw materials an opportunity to follow suit.

Certainly the cost of chemicals and other raw materials has a powerful influence on the prosperity and productivity of manufacturing industry generally, and as just one instance we have Sir John Hanbury-Williams, c.v.o., chairman of Courtaulds Ltd., pointing to the increased prices of chemicals as one of the factors which help to swell his company's costs; he gives as an example caustic soda, which has risen by 40%. Sir John's comment on chemical prices was included in his annual review of Courtaulds' affairs, in which he also mentioned an even more noteworthy rise in the price of coal—by over 70%. He, too, expressed recognition of a need for industry to join in the anti-inflation struggle.

It is from the big companies that the lead is expected—and usually comes—and so it was encouraging to have Imperial Chemical Industries' approval of the statement on inflation and prices which had been issued jointly by the F.B.I. and other bodies, and the announcement that I.C.I. have decided to make no further increase in the home-trade prices of the company's chemicals, dyestuffs, explosives, fertilisers, fibres, paints, pharmaceuticals and plastics at least until June 30, 1957—provided no unexpected or exceptional factors intervene and provided the company does not incur any major increase in the cost of freight or fuel before that date.

In making this announcement, I.C.I. point out that they have long practised a policy of increasing productive efficiency in combination with price restraint and that, as a direct consequence of this policy, the weighted average of the company's home trade selling prices has advanced by only two-thirds during the ten years since 1946, although the purchase price index for I.C.I.'s raw materials has increased to two-

and-a-half times the level in 1946, and over the same period the I.C.I. index of earnings per employee of all grades has doubled.

A recent example of I.C.I.'s price-reduction policy is the lowering of the price of their *Alkathene* (polythene) and its compounds by 3d./lb. This became effective from August 1 and is the third price reduction in three years.

Another body has recently taken a decision about prices of which the chemical industry as much as any will feel the benefit. This is the British Laboratory Ware Association, which has resolved that, from the beginning of this month, its members will maintain their own existing prices for laboratory apparatus, both in the United Kingdom and overseas for six months.

These and similar gestures from industry, the various sections of which are becoming increasingly interdependent, cannot fail to make an impression on the present situation, to the ultimate benefit of all.

New uses for glass fibres

RAPID growth of the glass-fibre industry in all parts of the world was revealed at an international conference which was held at Oxford recently and attended by representatives of the industry from 20 nations.

When it is recalled that the first glass fibres were drawn, one at a time, by the Egyptians nearly 3,000 years ago in the very first efforts to make and to decorate small glass vessels for holding scents and ointments, it is surprising to find that it is only 30 years ago that glass fibres began to be made by industrial processes for practical uses. Today the world output is getting on for 200,000 tons.

With rising standards of comfort and with rising fuel costs, the use of glass fibres is increasing rapidly for the insulation of buildings. From far beyond the Arctic Circle in Finland, at the plant of the biggest iron mine in the world (at Kiruna), through the tropical heat of Brazil and Africa down to the southern tip of Chile, houses and industrial buildings are insulated with glass-wool products. But many other uses besides these have been and are still being found; the most recent application is to use these fibres to reinforce plastics, upon which they confer strength and toughness of an extraordinary degree. Indeed, makers of these materials point out that, weight for weight, a glass-reinforced plastic is practically the strongest material available today. At the conference, it was clear that, in the more advanced fields for the use of glass fibres, Britain, for the time being, has the lead outside the United States, but rapid development is also taking place in Europe.

The delegates to the conference visited the Ravenhead works of Fibreglass Ltd. at St. Helens, Lancs., where about 1,000 people are employed and which is laid out on modern and attractive lines. The Ravenhead plants are in full occupation supplying glass-fibre products of all kinds, one order being dealt with at present being for the covering of 150 miles of 24-in. oil pipeline in Saudi Arabia.

Scale model cuts refinery building costs

CHEMICAL plant designers, particularly in the United States, are making increasing use of three-dimensional scale models as an aid to planning and, as we pointed out in a previous note on this subject (see CHEMICAL & PROCESS ENGINEERING, 1954, 35 (11), 338), the cost of an engineering model of a chemical plant is estimated to be small compared with the savings in piping drawings, pipe and fittings, and sub-contracting work.

So, if the reader is inclined to feel slightly groggy on hearing the cost of a scale model which Shell are using as a three-dimensional blueprint at Pernis (Rotterdam) refinery is £6,500, he will be immediately revived by the information that, despite its high cost, the model has proved an economic proposition and made possible many savings, particularly in drawing costs. Other savings were in the cost of pipework, painting, etc., for the plant; by studying the model, contractors were able to make more accurate estimates of the work involved and their tenders were, on average, 10 to 20% lower. The model is also being used for training operating staff.

Built of wood, plastic and copper to a scale of 1 in 50, the model, besides being invaluable in the design and planning stage, was also used for planning the erection of the shear legs when large components were being hoisted into position. The model is built in three parts: the catalytic cracker itself with fractionating column, the distillation plant in which the feed is prepared, and the gas treater. These are mounted on separate tables which can be placed together for studying the complete plant.

A few figures will serve to illustrate the size of the new plant at Pernis and the usefulness of the scale model: the plant involved a total of about 4,000 drawings, 1,900 piles, 2,000 tons (about 25 miles) of pipes of 2-in. diameter and over, 2,500 tons of steel structures (plus 1,200 tons in buildings), and has an installed capacity of 25,000 h.p. or 18,430 kw. The quantity of cooling water required is about 15 million l./hr.

So successful has the model been that models of new plant for other Shell refineries at Cardon and Curacao are now being made. These will cost £2,200 each.

A photograph of the Pernis model appears on another page.

New chemical and engineering standards

IN international discussions on the standardisation of methods of test for fine and heavy chemicals there have been strong indications that the preparation of recommendations for chemical products as well as methods of test will be pressed. This is pointed out in the annual report of the British Standards Institution, which reveals that the programme of standards for organic chemicals and solvents continues to expand. The Institution's own work on methods of test for fine and heavy chemicals has been developed during the year. In the chemical engineering section, work has included standards for gas cylinders, water

testing, silver plating, pressure vessels, process vessels and electroplating materials. Preliminary consideration is being given to a specification for glass-lined pressure vessels and work on sizes of process vessels for use in the chemical and allied industries is well advanced. Another related standard is B.S. 470, 'Manhole openings for chemical plant,' the draft revision of which has been issued for comment.

A committee has been formed to co-ordinate the work of several sections of the B.S.I., e.g. mechanical, engineering, petroleum equipment and chemical engineering sections, in relation to pressure vessels, heat-exchange units, etc. Attention will be given also to the needs of newer branches of industry such as the atomic energy industry.

An interesting development has occurred with a standard for flameproof electric lighting fittings. Research has led to a proposal, now being investigated, that satisfactory diffusion of the light source, to avoid glare, can be obtained by internal acid treatment of the glass. It is claimed that acid etching has been achieved on a production basis without detrimental effect on the strength or other physical properties of the glass.

Miscellaneous other work of the B.S.I. that is of interest to our readers, to select a few items at random, is concerned with oil storage tanks, pipeline welding, barytes and plastics tubing.

Comments on the progress of these and many other projects are included in the 260-page report, which is available from the British Standards Institution at 5s. net.

Work study in ammonia plant maintenance

REMARKABLE results from the application of work study to maintenance techniques at a heavy chemical factory have been revealed recently. Up to 1952, when work study began to gain impetus, normal good management at this factory was increasing productivity at an average rate of some 2% a year. The two subsequent years brought an increase of 32%, of which over 22% arose from the use of work-measured incentive schemes.

The factory concerned is a medium-sized, Government-owned factory which produces ammonia by the Haber process of synthesis at high pressure. The plant has operated continuously, day and night, since 1939. With regard to the more technical aspects of the drive to increase productivity—such as increasing the capacity of the equipment, improving the efficiency of utilisation of the more expensive raw materials and improving the availability of the plant—the technical staff began its investigations about 1947. Benefits were achieved much later owing to such factors as prolonged delivery dates for equipment.

The introduction to maintenance work of incentive schemes based on work measurement forced planning into the foreground. During the period of work-study application a system was adopted based on local experience and needs combined with a knowledge of systems of scheduling and planning operating elsewhere. A marked improvement in planning has resulted.

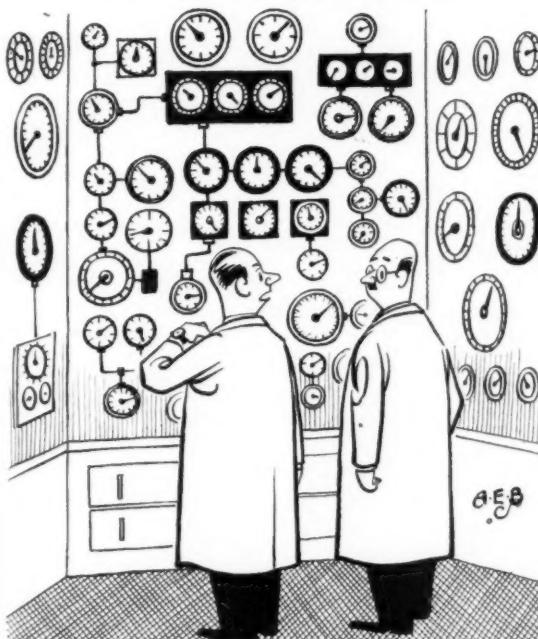
As a large proportion of plant is continuously operated and without running spares, a system was required having sufficient flexibility to cover all contingencies and give maximum availability of plant with minimum maintenance cost. To obtain latitude for the maintenance of such plant—for example, the overhaul of compressor components with widely divergent frequencies, catalyst changes, etc.—no fixed intervals between overhauls were laid down. Such units of plant are left in service until signs of distress or reduced efficiency indicate the need for attention.

By this means periods between overhauls have been stretched to the limit.

Items of plant covered by sufficient spares, together with any likely to cause danger to personnel or plant on breakdown, have been overhauled at predetermined intervals. Intervals were allotted in the first instance on experience, but were adjusted on the basis of information gained during each overhaul. Also, schedules for painting, lubricating, etc., have been prepared and introduced. As experience grew, the extent of overhauls was adjusted, i.e. where parts of a unit of plant require a higher frequency of attention than the remainder, partial overhauls of such parts have been instituted between major overhauls, and intervals between major overhauls have been lengthened.

All planning of the timing and programming of overhaul work is based on estimates supplied by the work-study estimators. The routine overhauls are controlled by the engineer, using a card index system. Little clerical work is required. Where spare plant is

Comical Engineering Situations



"I SUPPOSE YOU WOULDN'T HAVE ANY IDEA OF THE TIME?"

available, i.e. the water-gas and boiler installations, the overhaul work is charted for convenience.

To sum up, by the end of 1954, after two years' work, about 100 of the factory's 285 employees were on work-measured incentive schemes, and development is still proceeding. This has been achieved by a work-study staff of one work-study officer, five full-time estimators and a spare trained but working as a craftsman. In the same period the annual rate of increase of productivity has gone up eightfold. One effect of this can be seen in the cost of the finished product over the last 12 months. Although in the period the cost of raw materials rose by 7%—an increase which would normally be reflected directly in the final cost of the product—in fact, owing to the improvements in manning, in efficiency and in output outlined above, the effect on final cost was only of the order of 4%.

The details of this useful application of work study are given in 'B.P.C. Case Studies' No. 2, published by the British Productivity Council (2s. 6d.), which deals with plant maintenance experiences in a number of industries, including fertiliser production, oil refining, paperboard manufacture and steel tube manufacture.

Synthesis gas by partial oxidation

NEW ways of gasifying both coal and oil to obtain the most from them are constantly being sought, and an article in this issue describes one interesting process which is the result of an exploration into the possibilities of obtaining complete gasification of coal. For producing synthesis gases for synthetic ammonia, methanol and oils production, many systems of gasification are readily available, and a trend which can be discerned is an increasing tendency to use hydrocarbon feedstocks in place of coke or coal in countries or locations where hydrocarbon fuels such as natural gas, fuel oil, liquefied petroleum gases or refinery tail gases are available. Catalytic reforming processes and partial combustion processes using oxygen can be used for the production of high-purity hydrogen, synthesis gas or town gas.

A recent addition to the range of processes which the Power-Gas Corporation Ltd. offers for producing synthesis gas is the *Texaco* partial oxidation process, and several ammonia plants incorporating this process are now in successful operation. One of the major advantages claimed for the process is that gasification under pressure saves compression costs either by utilising feedstocks available at pressure or by pressurising the feedstock. Also, the plant can be readily adapted to use either gaseous or liquid fuels within the same reaction chamber and is designed so that a change of feedstock can be made after only a brief shut-down.

Described in a recent pamphlet issued by the company, the *Texaco* process will produce carbon monoxide and hydrogen from a wide range of feedstocks including heavy oils, refinery gases and natural gas. The process is normally operated at a pressure of about 350 p.s.i.g., but operating conditions can be varied to suit particular applications.

New chemical processes speed Britain's atomic energy programme

AS the necessary starting point for both military and civil atomic energy programmes, uranium has received a great deal of attention in the past year or so, the main reason being the spate of new discoveries, most of them on the North American continent, which have removed the danger of a world-wide shortage. But, as the world supply position grows easier, more attention has to be paid to the relative cost of production from new deposits; there is no question of paying almost any price for uranium. The forecast, made in September 1954 by the Director of the Raw Materials Division of the United States Atomic Energy Commission, that the acceptable price for uranium contained in a high-grade concentrate might become about \$10 (71s. sterling) per lb. has already received some confirmation.

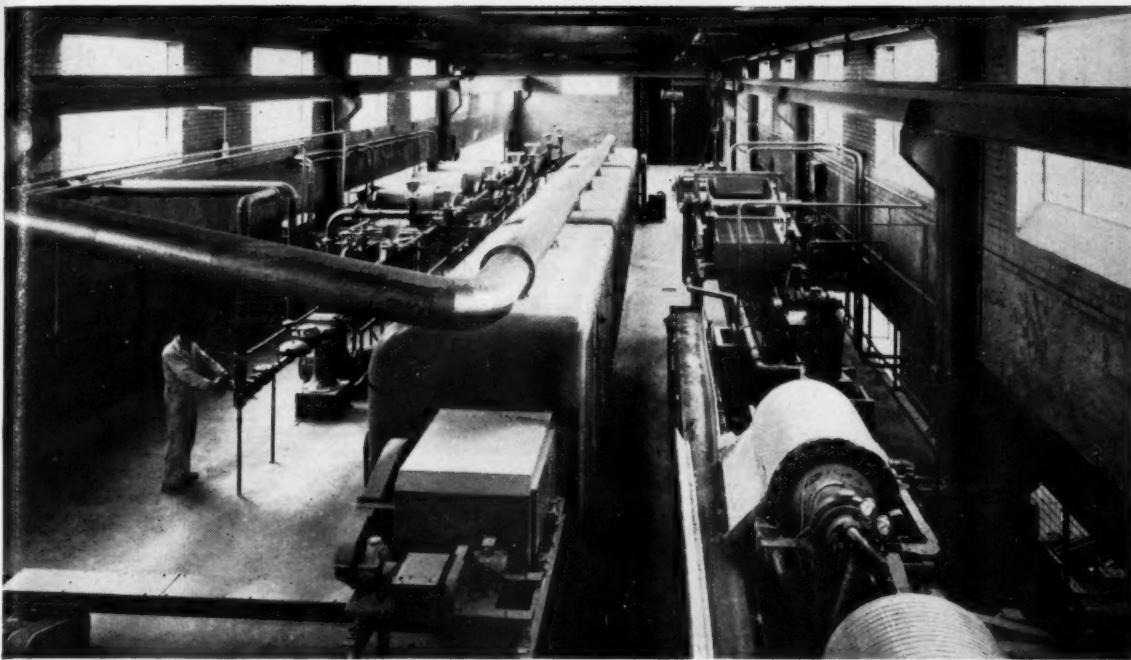
This subject was discussed briefly in the second annual report* of the United Kingdom Atomic Energy Authority, published recently. Among the technical developments referred to is the ion-exchange process for the extraction of uranium, which was described in our May issue. The Authority comments that, had this application not been developed, much of the greater part of the present uranium programme would not have been possible except at a vastly increased cost.

In addition to virgin material brought into the uranium production plant at Springfields during the year, a large accumulation of slags and other materials produced in the uranium purification process have been treated for the recovery of their uranium content. Uranium depleted in the 235 isotope through irradiation has, following treatment in the Windscale chemical separation plant, been converted to the hexafluoride for re-enrichment in the gaseous diffusion plant at Capenhurst.

It has been decided that the first stage in the modernisation of the uranium extraction plant should be to change from calcium to magnesium as the means of reducing uranium tetrafluoride to metallic uranium. This will lead to a big saving in raw material costs. The aim of development work on other sections of the process is to introduce continuous operation in place of batch working.

The treatment of irradiated uranium by dissolution in acid followed by extraction with organic solvents continues to be a successful method for the separation of plutonium and the recovery of uranium for re-use on the industrial scale. During the year further experience of this processing method has been gained on the pilot plant for the extraction of the fissile material uranium 233 from irradiated thorium. There have also been developments, both in the type of plant and in the solvents and chemical processes employed, to make the solvent extraction method suitable for the more immediate aims such as the treatment of irradiated fuels from DIDO and other similar reactors.

*H.M.S.O., 2s. 6d.



Mechanised Mica Production

Increased output has been achieved in new extensions to a Derby mica manufacturing works in which chemical engineering techniques are playing their part as well as increased use of mechanical handling methods. Some features of the plant, which has an output of about 4,000 tons p.a. at present, are noted below.

THE use of mica in paints and wallpapers has increased at such a rapid pace that a British firm of mica manufacturers, Micafine Ltd., decided to double the capacity—at present 4,000 tons p.a.—of their Derby works, although the original plant was installed only two years ago.

When the new extensions were opened recently they attracted considerable publicity because this opening coincided with the publication of a report by the D.S.I.R. on 'automation.' But this plant could hardly be described as an example of automation and, in fact, the management prefer it to be considered as the result of co-ordinating, in a labour-saving and time-saving way, various known mechanical processes. These are so incorporated into the original works that it is difficult to tell where new and old meet—a join in the concrete floor and newer-looking piping are all that meet the casual glance.

The material for processing into mica powder is imported as ballast in the holds of ships voyaging from India

and Africa as a residue after the sheet mica has been extracted by the electrical industry which uses it for insulating properties.

Wet grinding

The wet grinding of mica was started at Derby by Micafine Ltd. three and a half years ago, after considerable research and experience revealed this to be the best way of preserving the laminar structure of the mica, even down to the smallest particles. There are two units engaged in this process, each consisting of two grinding mills, five filters and a drying machine. These operate continuously and are looked after by five men on three 12-hr. shifts, but other staff also includes maintenance men, and men for loading and unloading sacks of mica and mica powder, bringing the total labour force to 55.

These figures are made especially interesting when compared with those

The illustration shows the top floor of the mica works. Here the mica is screened, filtered and dried.

of the original factory before the present Derby works were built. The labour force was 70 with an annual output of 1,200 tons. Abandonment of the old batch production process accounts principally for the change.

The mica has to be manhandled at one point only, where it is emptied from the lorries into hoppers. Thereafter the process is completely mechanised. The mica is taken from the storage hoppers which have a capacity of 4,000 tons into the system by grab crane which is also fitted with a means for weighing the mica. Preliminary crushing is carried out before the mica is taken by bucket elevator to the mills, where it is split into flat uniform flakes by the shearing action of one mica particle on another, in a paste consisting of 60% mica and 40% water.

In the old process the paste would have now been dried, screened and graded. Now it is only screened to remove oversize particles (which are returned to the mill).

The rest is mixed with more water into an easily handled slurry and



The hoppers for the storage of raw mica, whence it is taken into the system by weighing crane.

pumped to the top floor of the building in which separating and filtering is carried out. Oversize particles are again returned to the mill, the main slurry flowing down to the hydroseparation plant where the mica particles are graded.

Silica removal

The removal of silica, an important feature of the process, is carried out on a Wiffley table. This removes the silicone quartz by a process utilising the fact that mica and silica have different settling rates in water. The mica/water mixture is passed over the table and subjected to a controlled flow of water.

The slurry, now considerably thicker, is filtered, after which it is dried in carefully thermostatically controlled gas-fired ovens, and disintegrated into a powder. From the disintegrator the powder passes to a bagging hopper. This operates automatically, but the bags have to be cut loose by hand and also stacked and loaded by hand.

Product

In powder form, two grades are produced: *Micafine P* grade, which leaves only a trace on a 300 British Standard sieve, and *Micafine W* which leaves a 5% trace on a 150 B.S. sieve (or 50 to 60% trace on a 300 sieve).

For the wallpaper industry, a quantity of mica powder in the form of a wet paste, in drums, is produced.

Mica had for a considerable time been regarded as yet another filler or extender, but it is as a mineral reinforcing or improving agent that this

company's product is chiefly known.

Experiments and practice have revealed many qualities of mica—for example, improved adhesion (even in wet conditions), resistance to chipping and less tendency to crack during outside exposure. Research is continually opening up new uses for mica in surface coatings.

Some suppliers of equipment

Suppliers of equipment for the mica plant include Head, Wrightson & Co. Ltd. (mills); J. H. Carruthers & Co. Ltd. (hoists); Dorr-Oliver & Co. Ltd. (classifiers and hydroseparators); Riley Stoker Co. (screens and vibrators); and Hunt & Moscrop Ltd. (ovens).

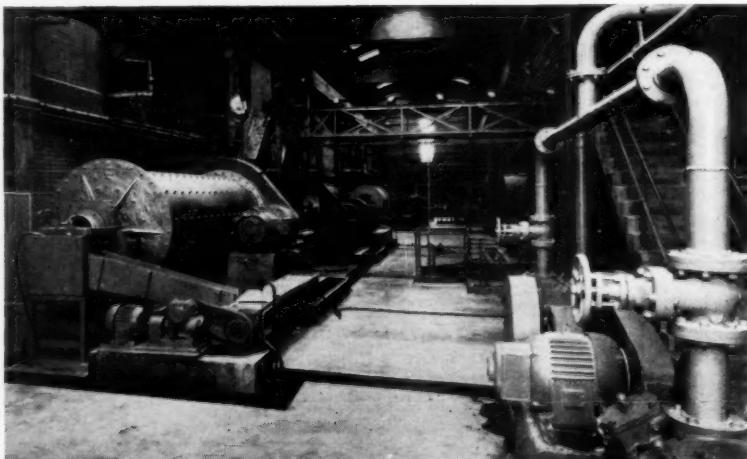
British participation in U.S. plastics project

An \$11-million plant for the manufacture of methyl methacrylate is to be built in Missouri, U.S., by Britain's Imperial Chemical Industries Ltd. and America's Hercules Powder Co. British Treasury sanction for I.C.I. to participate in this project has been obtained.

The new plant, with an annual capacity of 34 million lb., will be built on a 20-acre site at Louisiana, Missouri, adjoining the Missouri ammonia works owned and operated by Hercules Powder Co. The new company will make and sell both monomer and polymer in various forms.

Imperial Chemical Industries Ltd. was the pioneer of the process used throughout the world for the synthesis of methyl methacrylate monomer and is a major manufacturer of methyl methacrylate in all its forms. Hercules will bring to a new company a technical organisation experienced in U.S. production methods, and an established position in U.S. markets, plus the advantages of a site where the basic raw materials are available. Ammonia and methanol are produced at the Missouri plant, and natural gas is available in unlimited quantities from an adjacent pipeline from Texas gas fields. Hercules produces a fourth raw material, acetone, at one of its newest chemical plants, in Gibbstown, N.J.

Methyl methacrylate is made on a large scale by only two other companies in the U.S. and at present its main application is as a plastic polymer. U.S. consumption has doubled between 1949 and 1955.



After leaving the hoppers the mica is mixed with water to form a thick paste and is then split into flat uniform flakes by these mills.

FRACTIONAL DISTILLATION

Laboratory tests; vapour-liquid equilibrium; design calculations; packed columns; plate design; azeotropic separation, etc.

By H. H. M. Jones, B.Sc., A.M.I.CHEM.E.

RECENT work in the field of fractional distillation may be summarised under various heads as follows:

Laboratory

The testing of laboratory fractionating columns is described by Levin and Semenyuk.¹ Two mixtures for less than 50 plates (benzene dichloroethane) and for 50 to 300 plates (heptane iso octane) are recommended. Buchmakin,² on the other hand, shows that benzene/carbon tetrachloride can be relied on for checking column efficiency up to 500 plates.

Zel'venskii and Shalygin³ apply the radioactive tracer technique to the test procedure. Their test solution is thiophene benzene, which they compare with the solutions given above; it was found to be well suited.

Actual laboratory columns and ancillary equipment were described by various workers. Capatani and Milani⁴ give elaborate sketches suitable for both continuous and batch operation. Batch operation is the function of the apparatus described by Clauson-Kaas and Limbourg⁵ for temperatures up to 200°C.

Automatic columns are aided by a distillate/reflux head developed by Bukala *et al.*,⁶ which is an electronic device based on the dielectric properties of the liquids. Another paper⁷ describes its use in terpine separation.

Three packings made of glass textiles and their H.E.T.P. are described by Hala *et al.*⁸

Vapour-liquid equilibrium

The analytical approach to the quantitative solution of a two-component two-phase (vapour/liquid) system is attempted by Frolov.⁹ The Rayleigh equation is integrated by the substitution of the Dalton Raoult law for each of the components in the residue and distillate. Very good agreement with graphical analysis, especially over narrow temperature ranges, is reported.

The effect of association on the vapour liquid equilibrium for a multi-

component system is investigated by Marek and Standart.¹⁰ Thermodynamically consistent relationships are derived.

Improved types of equilibrium still are suggested by several workers. Hipkin and Myers¹¹ use a separate vapour jacket to replace the heater; there is negligible entrainment. Data on heptane/toluene and methanol/carbon tetrachloride are given.

An extremely accurate still is described by Rose and Williams.¹² Here again the principle of 'self lagging' with the vapour to maintain adiabatic conditions is used. Data obtained was compared with that of other workers by plotting equilibrium curve predicted by boiling-point data and calculating the R.M.S. deviation from experimental values. Such deviation was less than half that reported with other apparatus.

Other stills are described by Ellis and Thwaites;¹³ they also give data on the ethanol/benzene and propanol/water systems by Riccoboni *et al.*,¹⁴ whose still can be used above atmospheric pressure, and by Vilum *et al.*¹⁵

An unusual system, that of ozone/oxygen, is the subject of extensive work by Jenkins and Birdsall.¹⁶ There is no azeotrope, but the results conflict with those of Schumacher.¹⁷

A series of papers by French workers deals with various aspects of the problem of the determination of equilibrium data. In the first of these,¹⁸ Delzenne uses the Gibb-Duhem equation to compare results from two methods for providing data on the benzene dimethyl formamide and methanol dimethylformamide systems. In the second, Cathala *et al.*¹⁹ describe a dynamic ebulliometer; this is based on the theory that liquid and vapour streams are brought into contact and then separated. In the third, by Potier,²⁰ the apparatus is applied to the establishing of the isobaric diagram for nitric acid water at two pressures. In the fourth, Rivenc uses the apparatus for water/acetic acid and notes some of its limitations.²¹

Two papers by Ellis and Freshwater

deal respectively with the calculation of the relative volatility of ideal mixtures from vapour-pressure data²² and the use of activity coefficient data for non-ideal systems.²³

Calculations

In the field of binary separation Rodriguez²⁴ gives two nomographs useful in the preliminary design work. Ellis and Freshwater²⁵ review various calculation methods and give examples. An analytical solution for the 'crowded ends' of the McCabe-Thiele diagram is put forward by Blick.²⁶ Extensive mathematical analyses of the various calculation methods are made by Stage and Juilfs,²⁷ depending on the slope of the equilibrium curve so are some methods found more reliable than others. Nomographs enable plate numbers to be quickly calculated. The same authors²⁸ conduct a similar enquiry into methods for calculating H.E.T.P. and H.T.U. for packed columns. The effect of pressure on the separation of heavy water is studied by Szapiro;²⁹ results were in agreement with the McCabe-Thiele method. Problems of mass transfer were studied by Estaf'ev *et al.*³⁰ based on the original method of Sorel.³¹ The general equation deduced therefore allows for thermal changes. Rose and Bliss³² review the information on the relative volatility of binary mixtures at finite reflux and develop a series of modified analytical equations.

The stripping and rectification of ternary and quaternary mixes is the subject of several papers by White.³³⁻³⁶ The differential point concentration method of Ponchon and Savarit³⁷ in a simplified form is recommended by Ellis³⁸ for unit operation equilibrium calculations, and examples of the separation of ternary mixtures are given.

There is the usual crop of papers concerned with the analytical solution of multi-component mixtures. Ellis and Freshwater³⁹ discuss the various methods available for both batch and continuous fractionation. Klein and Hanson⁴⁰ use a five-component mix-

ture to illustrate the equations of Underwood,⁴¹ which are solved with the aid of determinants.

The series of papers by Acrivos and Amundson on the steady-state fractionation of multi-component mixtures in an ideal cascade is continued. In the first,⁴² the numerical plant methods are discussed and an example solved with a punched card computer. In the second,⁴³ the calculation of minimum reflux is developed. From calculations of ternary mixtures, Mirkin⁴⁴ proceeds to multi-component mixtures.

Kuhn *et al.*⁴⁵ develop the theory of distillation in terms of a separation parameter. In a second paper⁴⁶ a graphical solution of the analytical equations is given and its use shown in the design of equipment.

The simplification of multi-component to binary mixtures is suggested by van Wijk and Thijssen.⁴⁷ Two hypothetical components are assumed in the stripping and rectifying sections. Graphical methods are then used to determine the vapour/liquid ratio of any component on any plate.

The well-known Lewis and Matheson method is simplified by use of nomographs by Rodriguez and Walsh.⁴⁸ Trial and error in the determination of number of plates is eliminated without the assumption of a constant relative volatility.

Petroleum distillation problems lie in a somewhat different field and Edmister⁴⁹ offers an improved integral technique. Here the summation of K values for mixtures of a finite number of components is replaced by a graphical integration method for an infinite number. This principle is illustrated by application to fractionation.

Finally, Eshaya⁵⁰ presents a simple general method for multi-component calculation. Tables are given of functions which are used and which are dependent on equilibrium ratio, reflux ratio and number of plates.

Bubble-cap plates

Information valuable in bubble-cap plate design can be deduced from the experiments of Kirschbaum⁵¹ on the effect of reflux ratio on plate efficiency, of Spells⁵² on bubble formation in submerged slots, and of Simkin *et al.*⁵³ on entrainment here correlated in terms of the usual plate and operating variables. The last paper also deals with the Turbogrid tray.

Various aspects of plate design are dealt with in a series of papers. Gautreaux and O'Connell⁵⁴ show how the length of the liquid path on the degree of liquid mixing is related to

plate efficiency. Thijssen⁵⁵ illustrates the importance of experimental work in measurement of flow through downcomers.

The importance of compensating for the hydraulic gradient in large trays is emphasised by May and Frank,⁵⁶ who make a distinction between hydrostatic and hydraulic gradient. The derivation of an equation to determine the latter is given by Bijawatt.⁵⁷

For the special case of operation under pressure (e.g. separation of hydrocarbon gases), Clay *et al.*⁵⁸ show how the pressure can be determined at which several mutually compensatory factors result in optimum conditions and high capacity.

The correlation between the size of weep holes and other column dimensions is discussed by Broddus *et al.*⁵⁹

Packed columns

The more fundamental aspects of the fractionation process in a packed column are investigated by several workers. Brusset and Chahvekilian⁶⁰ present a mathematical study of the number of theoretical plates in the light of the theory of interfacial films. Koyanagi *et al.*⁶¹ show that the relative magnitudes of the individual film resistances vary according to the ratio of vapour, and liquid loads time to the slope of the equilibrium curve. Experimental work shows how the H.T.U. may be correlated on this basis. The concept is an extension of the work by Bliss *et al.*⁶² Acrivos and Amundson⁶³ extend their previous investigation⁶⁴ of steady-state fractionation of multi-component mixtures in an ideal cascade to packed columns.

In the examination of the effectiveness of various forms of packing, there are numerous papers. Among them Levin *et al.*⁶⁵ show that a special three-edged spiral of copper is most efficient, being rather surprisingly not affected by the column being deflected 45° to the vertical. Another gauze packing described by Fastovskii and Petrovskii⁶⁶ is more efficient on the basis of empirical mass-transfer measurements than rings and saddles. Two investigations of the efficiency of porcelain rings in laboratory columns (Gel'perin and Vil'shau⁶⁷) show that in two columns of different diameter the efficiency of packing is a maximum at the bottom and a minimum in the middle. Serwinski and Szapiro⁶⁸ show, once more, that as a concept of packing efficiency the H.T.U. is more reliable than the H.E.T.P., since it is less dependent on liquid composition.

Bushmakina and Lyzlova⁶⁹ introduce

a theoretical plate concentration diagram to express packed-column efficiency. This is the ratio of plates at normal and infinite reflux.

Eleven different types of packing and their suitability for various applications were investigated by Levin.⁷⁰ In two papers, Bushmakina *et al.*⁷¹ and Bushmakina and Lyzlova⁷² are concerned with the efficiency and reproducibility of packed columns. There is interesting information on the effect of an insulating jacket and of reflux redistribution.

Ellis and Freshwater⁷³ compare H.E.T.P. for various types of packing materials, showing that the gauze type is the most effective.

Papers having a more definite practical aspect are provided by Garner *et al.*⁷⁴ with a correlation of the loading velocities in packed columns based on data of their own and of other workers, and by Kirk and Fenske⁷⁵ with data on the separation of ternary mixtures in a pilot-scale column.

Finally, Yoshida and Koyanagi⁷⁶ show that coke has a lower H.E.T.P. than rings and other packings of the same size and is considerably cheaper. Its large hold-up is the disadvantage.

Perforated plates

Two laboratory investigations of perforated-plate columns are reported. It is shown by van Wijk and Thijssen⁷⁷ that plate efficiency is high and independent of liquid composition at total reflux, but falls sharply when product is removed from the column. Chahvekilian⁷⁸ expresses efficiency in terms of rate of distillation.

Johnson *et al.*⁷⁹ use the data of Mayfield and Church⁸⁰ to illustrate the application of charts for the estimation of column diameter, weir height, etc.

Two papers deal with the efficiency of perforated plates in separations at low temperature. Hanson⁸¹ attempts to predict point efficiency on a plate separating nitrogen/oxygen mixtures if the overall efficiency is known. He presents curves based on height of foam, pressure drop and vapour velocity. Overall plate efficiency under similar conditions and depending on the same factors is investigated by Linde.⁸²

Azeotropic and extractive distillation

The two methods are compared by Dummett,⁸³ who also describes⁸⁴ several types of azeotropic separation.

The application of azeotropism to the dehydration of hydrazine is described by Wilson *et al.*⁸⁵ using aniline

as entrainer. This yields a minimum boiling azeotrope (aniline/water) and a maximum boiling azeotrope (hydrazine/water). A process was worked out comprising three operations. The separation of gasoline mixtures using nicotine as an entrainer was analysed by Gorog and Szabo.⁸⁶

The opposing problem of the separation of binary azeotropes was tackled by Gel'perin and Novikova,⁸⁷ who suggested stepwise rectification at two different pressures.

A laboratory column for the continuous separation of azeotropic mixtures is described by Gotthard.⁸⁸

General

An important contribution to the study of plate efficiency is contained in the third annual report of the committee set up for the purpose by the American Institute of Chemical Engineers.⁸⁹ The results are given of an experimental programme in which the effect on liquid and gas film was examined separately, depending on which was controlling. All the usual variables were investigated and a factor *F* introduced; this is the product of linear gas velocity through the bubbling area and the square root of the gas density with the liquid rate as a parameter. Efficiency decreased slowly with increasing *F* and increased slowly with increasing liquid rate.

The effect on rectification with a simultaneous chemical reaction is described by Marek.⁹⁰ In the calculation of the number of plates, material and heat balances in the liquid phase must be included.

The application of kinetic considerations to fractionation by the use of molal velocity curves instead of pressure temperature curves is described by Deymer.⁹¹

Low-temperature fractionation in gas separation is the subject of an investigation by Grassmann.⁹² Emphasis is on the heat and mass transfer between bubbles and liquid in oxygen/nitrogen mixtures. It is found that the mass-transfer coefficient is independent of superheating or undercooling of the liquid and depends only slightly on concentration difference between liquid and vapour.

Schlatterer⁹³ reviews the operation of the double column in air separation plants; the influence of preliquefaction and sub-cooling is considered in detail.

In batch distillation, Johnson *et al.*⁹⁴ present analytical equations for binary separation. They use pseudo equilibrium curves which lead to simple, accurate equations; the latter facilitate

greatly calculation where the plate number is large. No hold-up is assumed while Chahvekilian⁹⁵ investigates the role of the rate of reflux and the quantity of material retained in the column. He recommends that the effect of various factors should be weighed in determining the optimum reflux rate. Such effect can vary from favourable to unfavourable, depending on circumstances.

There are several papers of what might be termed a 'plant' nature to be noted.

Pennell⁹⁶ reviews various methods for heating fractionating equipment; Slade⁹⁷ concentrates on corrosion resistance and gives examples of glass and glass-lined apparatus.

Description and design of specific equipment for specific separations are given by Ellis and Freshwater^{98, 99} for terpene fractions, by Tsyplkma¹⁰⁰ for vacuum separation of polycyclic compounds of coal-tar resins, and Dobrowski¹⁰¹ for the rational separation of fatty acids in a series of columns.

General advice on the design and selection of plate columns is provided by several papers. Katzen¹⁰² gives performance data for bubble-cap, Uniflex, Flexitray, Turbogrid and perforated-plate columns. Coulter presents the fundamentals of fractionation as applied to petroleum operation.¹⁰³ A second paper¹⁰⁴ is devoted to bubble-tray and packed columns, a third¹⁰⁵ to dehydration and steam distillation, and a fourth¹⁰⁶ to column control. Ellis and Freshwater¹⁰⁷ also discuss miscellaneous features of plant design and give illustrations.

Detailed description of the fractionation equipment for the separation of petrochemical mixtures is given by Hopkins and Fritsch.¹⁰⁸ An interesting example of the use of infra-red analysis to fractionation control is given by Berger and Campbell.¹⁰⁹ It concerns the furfural extractive distillation of 2-butenes from *n*-butane.

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with all the electric welding processes applicable to aluminium has been issued by the Aluminium Development Association. This 96-page bulletin includes tabulated data and illustrations showing actual work carried out.

Power-Gas activities. In its new publication, 'The Power-Gas Group Review,' the Power-Gas Corporation Ltd. aims to include in each issue something of interest for its friends and clients throughout the world. The first number includes articles on the sulphuric acid industry and on gasholder reconstruction, along with commercial news and a list of the group's various publications.

Industrial plant in glass. A booklet giving details of their range of 18-in.-diameter industrial-plant-in-glass units has been issued by Q.V.F. Ltd. This 18-in.-diameter equipment is introduced to extend the range and scope of glass absorption, fractionating and wash towers, but the 18-in.-diameter columns and pipe sections are suitable for use under full-vacuum conditions and for positive pressures up to 6 p.s.i.g.

Fuel economy. The 1956 edition of the annual 'Fuel Economy Review' was published recently by the Federation of British Industries at 5s., post free. The review, now in its 34th year, contains ten illustrated articles on the economic and technical aspects of fuel saving, together with explanations of the Government Loan Scheme for fuel-saving equipment and of the work of the National Industrial Fuel Efficiency Service.

Aluminium. With aluminium now being used or contemplated for a growing variety of purposes in the food and chemical industries, it is not surprising that queries are frequently raised as to its suitability for specific applications. The designer of chemical plant, for instance, may need to know whether the metal will withstand any destructive action of the substance being handled, or whether precautions must be taken to prevent contamination of the product itself. A manufacturer of insecticides may perhaps wonder whether a new formulation can be safely marketed in aluminium dispensers. The purpose of a 90-page illustrated booklet obtainable from Northern Aluminium Co. Ltd. is to assist in answering questions of this nature. It lists the reactions of aluminium with over 500 common food and chemical substances, and indicates, where appropriate, the extent to which aluminium has been used in the past.

Recent Publications

Petrochemicals. British Hydrocarbon Chemicals Ltd., a joint interest of the British Petroleum Co. Ltd. and the Distillers Co. Ltd., has brought out a 24-page booklet describing and illustrating its plant at Grangemouth, Scotland. Between the last quarter of 1955 and the early part of 1957, new construction will duplicate the existing cracking and gas-separation plant and the ethyl alcohol plant, and will provide units to extract butadiene and to make tetrapropylene. A large part of the booklet describes and illustrates the present plant.

High-alloy castings. Dewrance & Co. Ltd. have recently issued an illustrated publication, No. 682, which describes briefly their high-alloy castings, which can be used under conditions of heat, abrasion, corrosion and erosion, and can be supplied 'as cast' or machined to suit customers' individual requirements.

Stainless steel. Among the new items published by the Talbot Stead Tube Co. Ltd. are the following: (a) stainless-steel tube catalogue; (b) stainless-steel fittings catalogue; (c) range-of-products booklet (also published in French and German); and (d) table of steels used for Metier stainless-steel tubes.

Arc welding of aluminium. A new information bulletin which deals

IS COAL A USEFUL SOURCE OF METALS?

By I. Berkovitch, M.Sc.(Tech.), F.R.I.C., A.M.I.CHEM.E.

The author summarises briefly the available evidence that coal may be a commercially exploitable source of metals, and shows the need for a thorough exploration of the possibilities from both the scientific and economic points of view.

GETTING wealth from waste is always an attractive idea and it is interesting to consider the possibilities of getting metals from the ash of coal after the fuel has been used for one of its normal purposes.

On the one hand we constantly hear alarming prophecies that we may soon exhaust our mineral supplies. On the other, we find that coal contains an almost unique range of trace elements. Most of these are metals and they are usually found in increased concentration in the ash.

What solid information is there to enable us to judge whether the ash really can supplement our mineral supplies as a source of metals?

So far the main emphasis on uses for the ash has been for making building materials. In Britain, the Central Electricity Authority in collaboration with the Building Research Station have shown how fly ash—mainly small spheres of fused ash resulting from pulverised fuel firing—may be applied. It can be blended with conventional clay and used for making bricks or can replace part of the cement in making concrete. It can also be used to make lightweight aggregate.

At present the only metal known to be extracted from coal is the useful semi-conductor germanium,¹ and certain flue dusts today form Britain's major source of this element. This is a metal of increasing importance in the production of rectifiers and transistors used in compact, robust electronic gear. In Britain, conventional mineral sources of the element are not being drawn on. The fact that so far only these particular dusts have been shown to be rich enough in the metal to justify working them, shows up the need for more study.

Power stations alone expect to have about 4 million tons of fly ash to dispose of in 1960 and the total of ash

from all sources may then be about 10 million tons p.a. Of course, it will not always be available conveniently in bulk form.

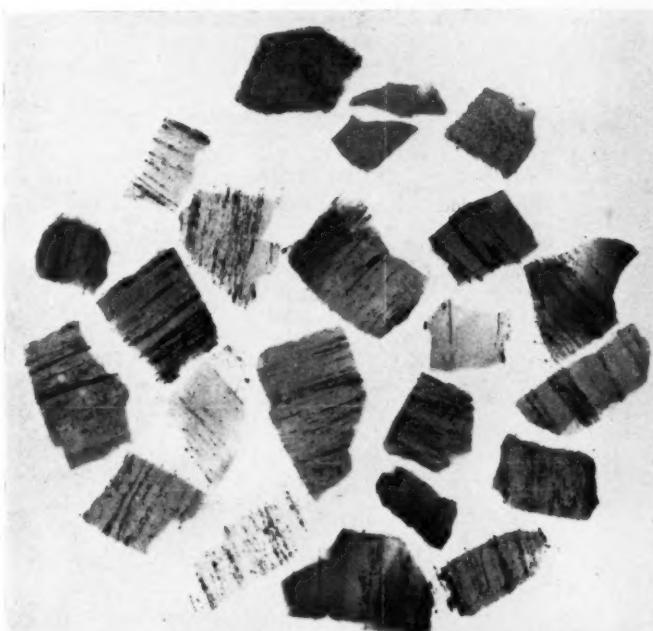
In studying this kind of use for the ash there are at least four stages involved:

- (1) A survey of the metals occurring in coal. Although this is a big undertaking, it should cover all our coal fields and the sequence of seams in each coalfield.
- (2) A survey of what happens to each of these metals in the course of using the coal in various ways. To be complete

this should not only cover different kinds of equipment—various types of furnaces, boilers and carbonising plant, but it should also include taking a look separately at the dust settling in different sites within the plant.

- (3) Developing extraction processes for the metals from the ash.
- (4) Making at least rough estimates of the cost of production from this free source to see if it would compete with that of the metal as normally marketed.

Let us examine each of these points in turn.



[Courtesy: British Coal Utilisation Research Association]

Radiograph of parallel-sided sections of vitrified coal containing about 1.8% ash. All except four (the group shown at the top of the photograph) were ground perpendicular to the bedding plane. The mineral matter is shown as black streaks of minerals of groups M (shale group) and K (kaolin group), and also as minute black specks or stringers of minerals of group S (sulphide group). Magnification $\times 5$.

Metals in mineral and organic matter in coal

The basic data are those which come from careful scientific surveys of the elements in coal with special reference to the metals. Most attention will therefore be devoted to this theme.

Coal always gives a residue that will not burn and which everyone knows as the ash. Part of it comes from the silt blown into the decaying organic matter hundreds of millions of years ago at some time during the long period while the coal was being formed. Some of this can be seen as 'dirt' bands or white streaks in the coal; there may also be golden streaks from the sulphur mineral pyrites. Even when none of these can be seen with the naked eye, particles of them exist finely dispersed in the coal.

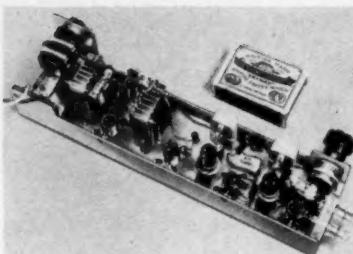
There are also metals chemically combined with the organic coal substance. This fact links up with the findings of workers on living plants that many metals are needed in traces for the healthy life of the plant. Evidently this was also true of the giant ferns of Coal Measures times which eventually became our present-day coal.

In 1949 the Fuel Research Station published the following list² of the concentrations of the major constituents of ash. This is derived from both the combined and the admixed constituents of the coal:

| | % |
|--------------------------------|----------|
| Silica (non-metal) | 25 to 50 |
| Aluminium as oxide | 20 to 40 |
| Iron as ferric oxide | 0 to 30 |
| Calcium as oxide | 1 to 10 |
| Magnesium as oxide | ½ to 5 |
| Sodium and potassium as oxides | 1 to 6 |

New approach: seeking desired minor elements

But these figures are the results of what are virtually nibbles at the problem of finding out what chemical elements are in seams, apart from the basic surveys covering carbon, hydrogen, oxygen and sulphur. Surveys of coal with chemical analyses have been largely devoted to finding out about properties which are important when using coal as a direct fuel or to make coke and gas. So both producers and users have a good general idea of the usual pattern of the moisture contents and calorific values of our coals and of those properties which are linked with the ability to make a good coke on carbonising the coal. In addition, the coke makers have wanted to know—and this brings us on to the minor chemical elements—about phosphorus and sulphur in their coals because



[Courtesy: General Electric Co. Ltd.]

Germanium has important uses in electronics as in this experimental radio receiver using germanium crystal transistors.

these are harmful constituents; people using flue gases to dry foodstuffs (notably chicory and malt) are naturally interested in arsenic contents; the Central Electricity Authority has now developed a great curiosity about chlorine since this has proved to be closely linked with boiler availability.

But these examples of attention to elements are cases where users are interested in the absence or the smallness of concentration of particular constituents. It is a relatively new development of the last few years that more emphasis is being given to thinking in terms of *desired* minor constituents and particularly metals. So far the main practical example of this kind of approach for possible extraction of a metal is that connected with the search for germanium—although there was some extraction of (the non-metal) sulphur at collieries during the war, and I understand that extraction of both iron and selenium is now being considered. The latter, of course, has important uses in making photo-electric cells. In addition, many workers have been interested in the effect of inorganic material on the behaviour of coal or coke in the course of normal use.³

Recent surveys of chemical elements in coal

The Fuel Research Station have from time to time published the results of limited surveys of the minor elements in coal or coal ash. In a recent example, Horton and Aubrey reported⁴ in 1950 that samples of one constituent from one seam—the famous Barnsley seam—were examined for 18 metals. They included well-known materials like copper, nickel and tin as well as others which are just coming into the public ken such as titanium, vanadium and zirconium. For example, there was often about one part copper per thousand parts of the ash; titanium ranged from 0.3 to

0.8% and vanadium occurred in concentrations of up to 0.5% of the ash. Incidentally, by separating the coal from a large part of its mineral matter, they found that most of these minor elements were linked predominantly with the organic part of the coal, although the relative abundance differs in some respects from that in modern living plants. All of the metals mentioned are important, either as well-established metals or as metals of increasing modern usage.

In West Virginia, U.S., the major coal-producing area has been similarly surveyed for the concentrations of 38 elements. Sixteen seams were sampled throughout their thickness to determine if there was any tendency to enrichment at any particular horizons in the same. There have also been other limited surveys in the U.S. and in other countries.⁵

Coming back to the United Kingdom again, the National Coal Board is now starting an extensive survey of both major and minor elements in the mineral matter of coal. In all, 38 elements will be covered comprising all that have been mentioned above and others, and within a couple of years a large amount of systematic data will be available. While this will provide information on potential desired constituents, the work will also include attention to elements which are of interest because they are poisonous, corrosive (for example, mercury) or harmful in other ways, such as contributing to formation of deposits on the flame side of boiler tubes as boron does.

Effect of combustion on metallic constituents of coal

This leads to the second stage of the study mentioned at the beginning of this article. During burning, the trace elements usually increase in concentration by at least ten times over the proportion present in the coal in general and may increase more in particular sites. That is why it is valuable to follow up the clues provided by the surveys of the coal itself with systematic studies of ashes from different types of combustion plant and from different points within it. This kind of segregation may result in enrichment to an extent that justifies selecting dust from particular sites as being especially valuable.

As part of the work on fly ash for building materials mentioned previously, C.E.A. workers have published a few analyses⁶ of the major constituents of some samples of fly ash. Since the ash is mixed and fused

during the burning, its range of composition is more limited than that of the dispersed ash from normal laboratory samples of coal.

Their published data includes nothing on minor constituents. It is worth noting, however, that some indication of this kind of separation is given by work on boiler deposits. In the superheater region of power-station boilers the deposits tend to be of ash particles cemented by alkali and acid sulphates. In the economisers, phosphatic deposits may occur.

Development of extraction processes

It is evident that finding even a gold mine does not automatically become a source of income unless there is a satisfactory process for extracting the gold from that particular form of occurrence. For some elements, purely academic chemists in the past have developed extraction methods which can be adapted to purifying the element from the ash. In addition, the Chemical Research Laboratory at Teddington has a section which seeks for valuable products from industrial wastes. It has, for example, played

a big part in devising processes for getting out germanium and another interesting metal which occurs in coal, namely gallium. This is one of the rather small group of low-melting metals and becomes liquid on hot days. In many cases, however, it may be necessary to get research chemists and chemical engineers to work on developing new processes.

Economic considerations

Finally, when there are competing sources of elements, a careful cost estimate is important at an early stage with some attempt at forecasting the economic trends in use and price of the metal. This will involve consultation between industrial chemists and economists.

Even from our present sketchy knowledge it is clear that coal ash is an unequalled, jumbled storehouse of metals. Economically, it starts from the advantage that it is free apart from the cost of taking it away. Against this is the fact that the elements are usually in small concentrations; to mitigate this disadvantage there is the further point that many of them are so valuable as

to be worth extracting even from poor sources.

On balance, it may be asked, is it worthwhile extracting them? Here only some of the issues can be set out. To make judgments on them we shall all need more facts.

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Solvent Extraction of Coal with Coal Tar Oils

NEW METHOD OF PRODUCING SMOKELESS FUELS

DURING work on the solvent extraction of coals at room temperature, it was observed that the undissolved residue yielded considerably less volatile matter in the B.S. test than did the raw coal. Recent tests show this to be true also for extraction at higher temperatures with phenanthrene or with tar oil fractions; as would be expected, much less smoke, therefore, is produced from the residue on burning than from the original coal.

The coal extract obtained as a by-product on removal of the solvent oil is potentially valuable, e.g. as a binder in the manufacture of moulded carbon refractories.

Further experiments have indicated that, by using ultrasonic vibration to aid extraction, a temperature as low as 100°C. can be employed, and a 90% yield of almost smokeless fuel can be obtained from a high-volatile coal. This burns practically without smoke, withstands normal handling and exposure to rain, and ignites readily. Apart from the advantages of the much higher yield of smokeless fuel obtained by this method than by high-temperature carbonisation, and the ready use of low-rank coals in the process, the fuel burns with a lumi-

nous, though smokeless, flame and is therefore preferable to coke for open domestic fires.

Laboratory apparatus has been constructed for batch production of the smokeless fuel, employing brief exposure to ultrasonic vibration to facilitate extraction. A continuous plant process could be developed using standard plant units except for the ultrasonic equipment; preliminary costing indicates that smokeless fuel might be produced economically by this means, and that plant construction costs would be much lower than for corresponding extension of gasworks production.

The essential steps are: (1) mixing finely ground coal with high-boiling tar oils containing such constituents as naphthalene, naphthols or phenanthrene, and heating to about 100°C.; (2) treatment of the mixture with ultrasonic vibrations for a few seconds; (3) filtration to remove oil and extract; (4) treatment of the residue on the filter with a low-boiling coal tar oil such as crude tar acids or benzole to remove the high-boiling oil, and extract loosened by the ultrasonic vibrations but not previously washed away; (5) removal of the wash oil by

washing the coal on the filter with a very dilute solution of detergent in water; and (6) briquetting the washed residue without binder.

Carbonised agglomerates

The foregoing work was described in the 1955 annual report, published recently, of the British Coal Utilisation Research Association, which also discusses further progress in the production of agglomerates by the carbonisation of coarsely crushed weakly caking coals on an oscillating tray, described in the 1954 annual report. Under optimum conditions over 90% of the feed is processed into agglomerates 1 to 2 in. in diameter. Control of the surface temperature of the metal tray deck and sides has proved to be a vital factor. High rates of heat transfer to the coal feed are possible, the total time required for heating and complete agglomerate formation being about 30 sec., but a high throughput is not at present attainable because of inefficient heat transfer from the refractory muffle surrounding the tray. Accordingly, present investigations are mainly concerned with improved methods of heat transfer.

(Concluded on page 313)

Chemical Engineering Aspects of BENZOLE RECOVERY

By A. R. Myhill, F.R.I.C., M.INST.GAS E., M.INST.F.

This article discusses some of the economic and engineering considerations involved in benzole recovery, which must be looked at from the separate viewpoints of the two parent industries concerned—the gas industry and the metallurgical coke industry.

ALTHOUGH gas works and coke ovens both carbonise coal, with the production of gas, coke and by-products, their objectives are very different. The main product of the gas industry is gas, with coke as a by-product, whilst that of the coking industry is coke, with gas as a by-product. This essential difference has a great bearing on the economics of production of all the products, including benzole.

Gas undertakings are required by law to provide a continuous supply of gas of specified calorific value, pressure and standard of purity. Coke ovens exist for the purpose of making coke of a special type suitable for the manufacture of iron and steel, and other metallurgical processes and, while gas must necessarily be produced as an essential part of the carbonising process, it is not the main product, and there is no obligation, except under special contract, to remove any impurities or maintain a particular calorific value. If conditions are favourable, part, or all, of the gas may be sold to gas undertakings for distribution to the public after purification and other treatment. Otherwise it may be burnt as fuel for heating the ovens, in an unpurified form.

The carbonisation of coal, whether in coke ovens or at gas works, produces about 0.1 gal. of benzole in the tar, and 2 to 4 gal. in the gas, per ton of coal treated.

The benzole in the tar is recovered during the usual process of tar distillation. In the economics of the coke-oven industry, the value of the gas is relatively low, and the value of the benzole, if left in the form of gas, is therefore also low. On this account, its recovery is economic and has become standard practice. Purified coal gas, however, is sold at a comparatively high price by the gas industry, and it is generally more profitable to leave the benzole in the gas than to recover it. The effects of removing benzole from town gas, which must be supplied

at a given calorific value, are a reduction in volume and a reduction in calorific value. The calorific value of benzole is approximately 1.5 therms/gal., or about 3,800 B.Th.U./cu.ft. as vapour in the gas. Coal gas from which benzole has not been extracted may contain up to an equivalent of 3 to 4 gal./ton of coal carbonised.

Supposing it to contain 1 gal./ton, the benzole vapour, equal to 39 to 40 cu. ft., could be diluted to make gas of, say, 475 B.Th.U./cu.ft., by the addition of 2.25 therms of blue water-gas produced from coke, either in a

separate plant or by steaming the charge in the retort. The removal of 1 gal. of benzole from the gas, per ton of coal, therefore reduces the yield of town gas of 475 calorific value by (a) 1.5 therms due to removal of benzole and (b) 2.25 therms due to the amount of blue water-gas (cal. val. = 290 to 300 B.Th.U./cu.ft.) which might otherwise have been added but for the reduction in calorific value by benzole extraction. There is thus a reduction of 3.75 therms, the value of which, as gas, must be set against the value of benzole recovered after making allow-

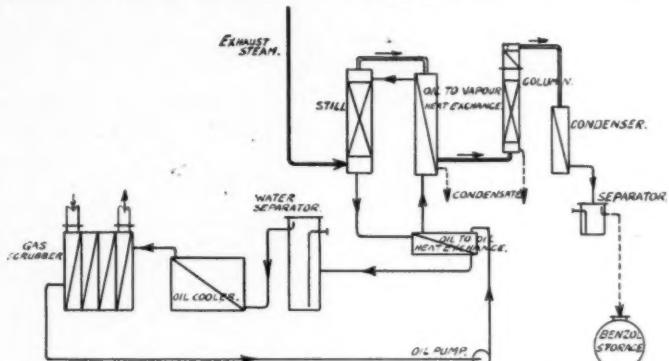


Fig. 1. Flow diagram of atmospheric-type oil-washing installation.

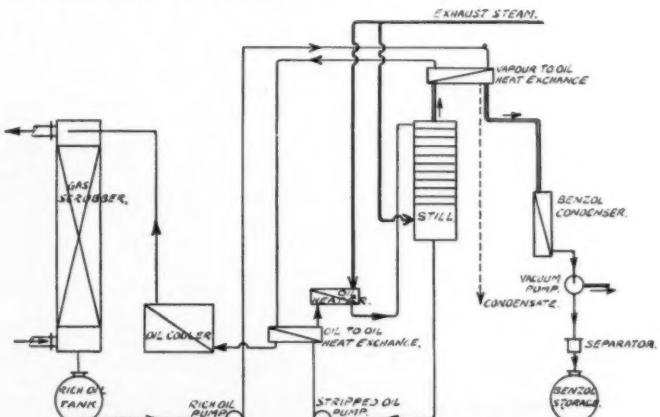


Fig. 2. Flow diagram of vacuum-type oil-washing installation.

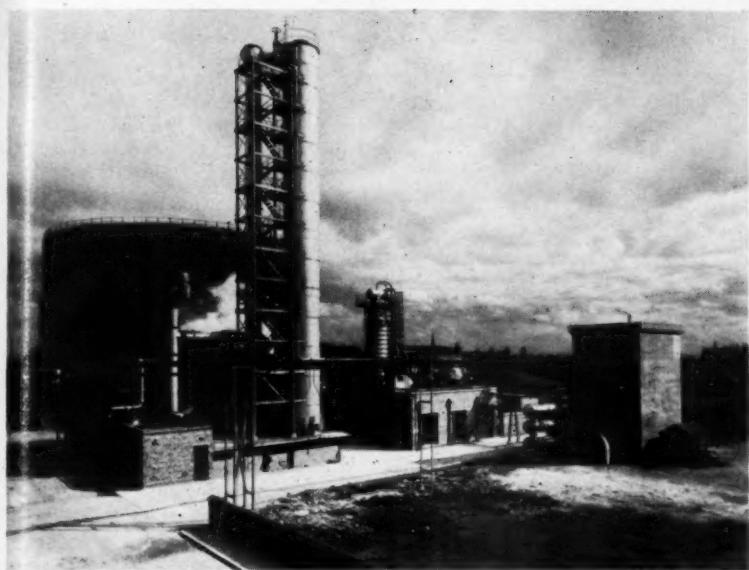


Fig. 3. Vacuum benzole plant at the Garston works of the North Western Gas Board, Liverpool Group.

ances for the use of more plant and extra revenue obtained from coke not required to make water-gas.

The debits and credits involved will determine the economics of benzole recovery in any particular case. It is not proposed to enter into further discussion of this aspect, which has many complications, especially in the advent of newer-gas-making methods. It will suffice to say that the most favourable conditions for the removal of benzole at gas works are to be found where there is a good coke market and the coke: coal price ratio is high. In general, present conditions are such that benzole recovery is not looked upon with very great favour in the gas industry, but is an economical proposition in coke-oven practice.^{1, 2}

Composition and characteristics of benzole

The composition of benzole varies somewhat according to factors related to gas production and the method of recovery. It is almost entirely a mixture of hydrocarbons with a boiling-point range of 45 to 200°C. The hydrocarbons belong to the paraffin, unsaturated, cyclic and aromatic series. Benzole recovered from gas produced in high-temperature static carbonising processes such as coke ovens, horizontal retorts and intermittent vertical retorts, contains a high proportion of aromatics, mainly benzene and toluene, while that obtained from gas made by low-temperature carbonisation processes or from steamed continuous ver-

tical retorts, contains a high proportion of paraffinic and unsaturated substances which impair to some extent its quality as motor spirit, or for making toluene and dyestuffs intermediates.

The composition of benzole according to boiling-point range may vary between the following limits:³

| | Boiling point, °C. | % by vol. |
|----------------------|--------------------|-----------|
| Fore-runnings, up to | 75 | 2-20 |
| Benzene fraction | 75 - 97.6 | 45-84 |
| Toluene fraction | 97.6-126.7 | 10-23 |
| Xylene fraction | 126.7-165 | 3-6 |
| Heavy residue | Over 165 | 0-6 |

In cases where benzole is recovered by washing the gas with oil, the higher the rate of oil circulation the greater will be the proportion of low-boiling constituents in the product.

All crude benzoles contain sulphur compounds, notably carbon bisulphide and thiophene. Since these substances have low boiling points, increase in rate of oil flow will result in the production of benzole of an increased sulphur content. This is sometimes taken advantage of in cases where it is required to distribute gas of low sulphur content for special industries, e.g. glass making. Benzole recovered by the activated carbon process will, in general, contain more sulphur compounds than that obtained by oil washing. It also contains a higher proportion of unsaturated substances, which necessitates higher costs in refining.

Methods of benzole recovery

It is possible to recover benzole from coal gas in several ways. These include compression and refrigeration, adsorption by solids, absorption by liquids, and chemical methods such as nitration, etc. Of these, adsorption by a solid (in practice, activated carbon) and absorption by a liquid (washing with gas oil or creosote oil) are the only methods normally practised in Britain.

Activated carbon process^{4, 5}

In brief, the method consists in passing gas through a layer of active carbon of a type similar to that used for gas masks. The substance retains the whole of the readily condensable constituents of the gas. When saturation is complete, these substances are recovered by heating the carbon with steam, partly as live steam and partly by closed coils.

The vapours, consisting of benzole and water vapour, are condensed and separated in the normal manner. The carbon is returned to a fresh state of activity by cooling and drying. Drying may be effected by recirculation of a portion of the preheated, debenzolised gas, while cooling is brought about when the carbon is once more exposed to the gas stream. Further cooling can be effected by passing water through coils within the carbon bed.

Adsorbers vary in number from two to six and consist of cylindrical steel vessels each containing a bed of activated carbon about 4-ft. deep. One or more adsorbers may be off stream at any time, for steaming out the benzole, the remainder being on stream for treating the gas. When an adsorber is on stream, water is passed through the coils to dissipate the heat of adsorption of the benzole. Test flames are located on the gas mains at the outlets of the adsorbers for the purpose of observing the 'break point,' i.e. the stage at which adsorption is complete. The change from (almost) non-luminosity to luminosity is an indication that a particular adsorber is saturated with benzole, and requires changing over to the steaming stage.

Owing to certain disadvantages, among which may be mentioned the necessity to free the gas from naphthalene and hydrogen sulphide before treatment in the adsorber, the activated carbon process has not been widely practised in Britain, although there are certain important exceptions.

Oil-washing processes

In view of the fact that most of the benzole recovered from coal gas is now

obtained by oil washing, it is proposed to consider these processes in somewhat greater detail. The removal of benzole by oil washing is a reversible solubility effect, so that the counter-current principle must be adopted in the washers or scrubbers. The general scheme of an oil-washing installation of the atmospheric type is shown in Fig. 1.

The type of washer or scrubber used is that adopted in normal gas-works practice for removing ammonia, and may be a tower scrubber, rotary brush washer or static brush washer with pumped oil circulation. In gas-works operation, the gas is washed in the purified condition, i.e. completely free from tar, ammonia and hydrogen sulphide, but in coke ovens, where the gas is sold or used for heating the ovens, the gas is often treated for benzole removal in a more or less unpurified state. In gas works, the washing medium is generally gas oil, whilst at coke oven works either gas oil or creosote oil, obtained by distilling the tar made in the works, is used.

After the gas has been treated in the washer, the oil containing the dissolved benzole is passed to a still or stripping column in which steam distillation is carried out in counter-current fashion. The benzole passes away to the condenser, and the oil, after cooling, is returned to the washer for re-use. In these operations, the maximum thermal efficiency (i.e. the minimum steam consumption) is achieved by heat-exchange devices.

The distillation plant may be of the atmospheric pressure type, operating at 120 to 130°C., or the vacuum type, which operates at about 80°C. The great advantages of vacuum distillation are (a) reduced steam consumption and (b) avoidance of oil-sludging troubles, often prevalent on plant working at the higher temperature range. Reduction in steam consumption is brought about by the use of exhaust steam from the gas washer, oil pumps and vacuum pump. Oil losses are greatly minimised by the avoidance of sludging. The following table gives comparisons of working by the atmospheric and vacuum distillation types of plant:

| | <i>Atmospheric plant</i> | <i>Vacuum plant</i> |
|---|--------------------------|---------------------|
| Steam consumption, lb./gal. of oil ... | 0.9—1.2 | 0.3—0.6 |
| Water consumption: gal./gal. of oil ... | 1.5—2.0 | 1.5—2.0 |
| Oil losses (%) on make of benzole... | 8.0—10.0 | 2.5—3.0 |

Vacuum distillation plant

The following description, which may be followed by reference to Fig. 2, relates to a typical large-scale installation erected by W. C. Holmes & Co. Ltd., Huddersfield.

The still has 12 cast-iron cylindrical sections fitted with bubble-cap trays. The bottom cylinder has a steam distribution pipe, oil-level gauge, man-hole and cover, and an outlet branch. The top portion of the still is tapered, and the final top section is fitted with an anti-spray device to prevent carry-over of spray with the vapours.

The bottom cylinder has a float-controlled valve to regulate the quantity of oil extracted from the still, which is under vacuum, and so to maintain a constant oil level in the still.

The still, fractionating column, vapour/oil heat exchanger, fractionating condenser, final condenser and naphtha separator are maintained under a vacuum of about 20 in. of mercury, by means of a vacuum pump, which works on the distillate from the final condenser and delivers to the separator. The latter is vented to the gas washer. To ensure a constant supply of steam, the steam manifold has a blow-off, set for 6 to 7 p.s.i., and a bleed from the main steam supply, regulated by a reducing valve set to admit steam when the exhaust pressure falls below 5 p.s.i. The benzolised oil is drawn from the B.O. tank by the circulating pump and forced through the vapour/oil heat exchanger located above the fractionating column, where heat is absorbed from the vapours leaving the still. The oil then passes through the oil/oil heat exchanger, where it is further heated by the hot oil leaving the still on its way to the steam pre-heaters.

Here the oil is heated in tubes by steam at a pressure not less than 60 p.s.i. The preheated oil enters the still and is stripped of the benzole vapours which have been absorbed from the gas, by an ascending current of live steam. The oil running from the bottom of the still is pumped through the oil/oil heat exchanger and thence to the cooler before passing to the washer at the gas outlet end. The cooler is designed to maintain a temperature in the oil sufficiently low for effective absorption of benzole vapour from the gas. The supply of live steam to the still is controlled by a valve and orifice plate, a pressure gauge reading giving an indication of the rate of steam flow.

The vapours from the still, consisting of steam and benzole vapour, pass

upwards through the fractionating column. On top is mounted the vapour/oil heat exchanger and fractionating condenser, the latter controlling the reflux to the column. The water supply to the fractionating condenser is governed automatically to give any desired temperature of the vapours at its outlet. In this way, the removal from the vapours of the required amount of naphtha to give any desired grade of crude benzole on condensation is automatically ensured.

The condensate from the fractionating column passes from its base through a seal, into the naphtha separator, from which the water flows to the drain and the naphtha runs to storage. Alternatively the naphtha may be returned directly to the top of the still. The benzole and water vapours pass to the final condenser. Condensate is removed via the vacuum pump, and discharged by a centrifugal pump to a receiver and separator, the benzole then being directed to the store tank.

A vent is provided in the condenser outlet for the small quantity of permanent gas and uncondensed vapour. In order to comply with the Alkali Works Regulations, etc., this vent must not be left open to air. In most cases, it is connected to the gas inlet to the washer and sealed below the normal oil level. This avoids loss of thermal value of the vapours.

The debenzolised oil is pumped away from the bottom section of the still, a float-controlled valve being fitted on a line running from the debenzolised oil pump delivery to the still. The float is controlled by the level of oil in the bottom section of the still and, if this falls, the valve opens to allow oil to flow back to the still.

In conclusion, the writer would like to acknowledge the assistance given by W. C. Holmes & Co. Ltd., Huddersfield, in supplying the illustrations and in giving details of the vacuum distillation plant.

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Carbonisation and Chemistry

By a Correspondent in France

Tremendous strides have been made in the recovery of valuable by-products from carbonisation processes since the days when the volatile gases from 'beehive' ovens were allowed to go to waste. This article summarises the progress that has been made with a special emphasis on developments in France.

CARBOCHEMISTRY may be defined as the entire group of industrial techniques which have as their objective chemical transformations of coals, and of their direct derivatives, with the exception of actual combustion.

The industrial exploitation of coal as fuel dates from the middle of the 18th century. At that time, a number of investigators, prompted by the work of various chemists of the 17th century on the distillation in retorts of the most diverse organic materials (it was in 1609 that the Flemish chemist Van Helmont gave to the volatile products evolved in that operation the name of 'ghoast' or 'spirit' which was eventually to become the word 'gas'), exercised their ingenuity in trying to find a way to obtain from coal a substitute for wood tar, large quantities of which were then used in the navy and the mercantile marine. At the same time, the inception of ballooning encouraged inventors to search for a 'light' gas which could replace hot air for filling the balloons.

Emergence of gas industry

It was the French engineer, Philippe Lebon, who, during the years 1796-98, laid the foundations of the gas industry on the basis of experiments on the distillation of wood in retorts. During the same period, William Murdoch, in England, was carrying out similar experiments on coal.

Neither of these inventors reaped any financial benefit from their work.

It was left to the Czech Winzler (who afterwards changed his name to Winsor) to establish the coal-gas industry, during the period 1802-07, as the first achievement of carbonisation chemistry. Pall Mall in London was lit by gas in 1807 and the Passage des Panoramas in Paris in 1817.

The industrial production of lighting gas from coal made great strides in Europe and in the United States during the first half of the 19th century (the Paris Gas Co. was formed in 1855 by the amalgamation of ten companies then in existence) and continued to develop up to the 1914-18 war more or less in its original form.

Coke (the residue from the distillation of coal out of contact with air) began to replace wood charcoal for the treatment of iron ores at the beginning of the 19th century and led to the construction, in about 1825, of the first coke ovens made of refractory materials to take the place of the 'stacks' similar to the stacks of wood charcoal, which were built in the open air.

Three periods in the development of carbonisation chemistry can be distinguished schematically; they overlap one another, but each of them is characterised by the opening up of a fresh channel without impeding the development of the older processes:

- (1) From the origination of the gas industry up to the 1914-18 war.
- (2) The period between the two world wars.
- (3) The post-war period.

Evolution of by-product recovery techniques in carbonising industries

Up to 1914, carbonisation chemistry was dependent on objectives connected with two different branches of industry: on the one hand the production of towns' gas and, on the other hand, the manufacture of metallurgical coke.

In both cases, the principle on which the treatment of the coal was based remained the same—distillation, out of contact with air, at a temperature between 800 and 1,100°C.—and the only differences were in the type of coal employed (more or less 'bituminous' or with a higher or lower content of volatile matter) and in the plant: horizontal retorts and, later, vertical retorts in the gas industry; chambers of refractory materials or cells in the coke-oven industry.

The production of towns' gas suitable for distribution through pipes entailed a system of purification, resulting in the recovery of what were termed, somewhat disparagingly, by-products (benzole, tar and ammonium sulphate).

At first, no recovery of the by-products was attempted in the production of metallurgical coke; the

volatile matter which was evolved with the gas was merely used for heating the chambers in which the coal was carbonised. It was not until 1856 that the first coke ovens with by-product recovery were built at Commentry. They were improved by the Frenchman, Carvès, of St. Etienne, before the 1870 war and thereafter were rapidly developed in every industrial country. At the present time, as a rule, all coke ovens are equipped with plant for by-product recovery; the United States is the only country in the world where coke ovens without by-product recovery, known as beehive ovens, are still operated.

Products of coal distillation

Leaving aside all details of the plant and the variations in the methods of operation, the following figures can be quoted as a typical yield from the high-temperature distillation of a suitable coal: a ton of bituminous* coal with 18 to 35% of volatile matter yields:

| |
|----------------------------------|
| 300 to 350 cu. m. of gas |
| 30 to 35 kg. of tar |
| 7 to 12 kg. of benzole |
| 5 to 10 kg. of ammonium sulphate |
| 700 to 800 kg. of coke |

The volatile constituents which are carried over with the crude gas are separated from the gas proper by condensation (tar), by solution in a heavy oil (benzole) and by chemical absorption in sulphuric acid (ammonia). Towns' gas undergoes further purification to rid it of volatile compounds containing sulphur and nitrogen.

The composition of a purified coal gas is approximately as follows:

| | % |
|---|----------|
| Hydrogen | 50 to 60 |
| Methane (and its homologues) | 25 to 30 |
| Carbon monoxide | 6 to 8 |
| Ethylene (and its homologues) | 1.5 to 3 |
| Nitrogen | 5 to 6 |
| Various other gases (oxygen, acetylene, oxides of nitrogen) | 1 to 2 |

*A coal is said to be bituminous when it melts at about 350 to 400°C. and the residue left on carbonisation is an agglomerated coke; anthracites, lean coals, and long-flame, non-caking coals do not melt, nor do they give a residue of agglomerated coke.

Depending on its physical properties, the coke is employed in heating installations, in blast furnaces or in foundries, or is used in the chemical industry as raw material for the manufacture of such products as 'water gas' (for the synthesis of methanol, ammonia and hydrocarbons) and calcium carbide.

The crystallised ammonium sulphate is employed directly as a fertiliser.

A second stage in the working up chemically of the by-products of the carbonisation process comprises the treatment of the crude tar and crude benzole which have hardly any direct application other than combustion; this is carried out either in the vicinity of the works where the tar and benzole are produced, or in separate factories, the present tendency being towards treatment in large units where the output from several works is centralised.

This second stage is similar in every way to the treatment of crude petroleum.

Crude tar

Crude coal tar is a viscous, black liquid, with a density varying from 1.05 to 1.15, and of a colloidal or pseudo-colloidal nature, in which more than 350 different substances have been identified, while many of its constituents still remain unknown.

The industrial treatment consists of partial or complete distillation; in both cases primary fractions are obtained which are either put to immediate technical use or are subjected to subsequent treatment for the purpose of extracting chemical products.

Complete distillation yields the following proportions of products:

| | % |
|-------------------------------------|----------|
| Light oil (distilling below 170°C.) | 1 |
| Carbolic oil (170 to 210°C.) | 2 to 4 |
| Naphthalene oil (210 to 230°C.) | 10 to 12 |
| Wash oil (230 to 300°C.) | 8 |
| Anthracene oil (300 to 360°C.) | 15 to 20 |
| Solid pitch | 50 to 55 |

Chemical raw materials of very great importance are extracted from certain of these fractions by chemical treatments, and include light hydrocarbons (toluene and xylenes), resins (coumarone-indene), bases (pyridine and its homologues), phenolic substances (phenol, cresols and xylenols), polynuclear substances (naphthalene, anthracene and carbazole).

The definite chemical compounds extracted from the crude tar represent about 10 to 12% by weight of the tar, but 30% of its value.

Tar products in industry

The oils, which amount to 35% of the crude tar, find various applications, the most important of which are: the preparation of the 'creosote' universally employed for the impregnation of timber which is exposed to the weather (railway sleepers, telegraph poles, etc.), the manufacture of binders for road construction, and the stripping of benzole and naphthalene from coal gas.

The pitch (50 to 55% of the crude tar) is a solid product which softens at about 70°C. and is mainly utilised: (1) as a binder for briquetting coal 'fines' (in France, 5 to 6 million tons of coal ovoids and blocks, agglomerated with pitch, are manufactured annually); (2) in the manufacture of electrodes; and (3) in the preparation of paints and coatings.

In some cases, only a partial distillation is carried out and this is stopped at 215 to 230°C.; the distillation residue is then used as a base for the preparation of binders for road work, their consistency being adjusted by addition of oils obtained from the coal. In France, about half the road system is surfaced with prepared tar. On these grounds, prepared tar may be said to occupy the first place—from the point of view of tonnage—among plastic materials.

Crude benzole

Contrary to the general opinion, only a very small proportion of benzole (2 to 4%) is derived from the distillation of tar. It is mainly present, in the state of vapour, in the gas (25 to 35 g./cu.m.), from which it can only be extracted by scrubbing the gas with a heavy oil which retains the benzole in solution.

The benzole is then stripped from the wash oil by heating and a crude benzole, which distills at 45 to 190°C., is recovered.

The crude product must be refined and rectified, the purpose of refining being to remove the non-aromatic substances (olefines and sulphur- and nitrogen-containing compounds). Until quite recently, the only method employed was treatment with sulphuric acid, which combines with the impurities without attacking the aromatic compounds to any marked extent. Nowadays, refining is preferably carried out by catalytic hydrogenation under pressure which acts on all the non-aromatic constituents without affecting the aromatic compounds.

The aromatics are extracted by fractional distillation in powerful plate columns.

One ton of benzole refined by hydrogenation yields, on an average, on rectification:

| | % |
|--|----------|
| Benzene .. | 60 to 65 |
| Toluene .. | 13 to 15 |
| Xylenes .. | 3 to 4 |
| Higher aromatic hydrocarbons (solvent naphtha) .. | 10 to 11 |

One constituent of crude benzole (1 to 2%), dicyclopentadiene, can also be extracted in a pure state; it is becoming important nowadays as a base for highly-effective modern insecticides (chlordane, aldrin, dieldrin, etc.).

Throughout the entire period extending from the middle of the 19th century up to the 1914-18 war, tar and benzole were the starting points for the enormous strides made by industrial organic chemistry (dye-stuffs, plastics, pharmaceutical products, explosives, etc.), which at that time were mainly based on simple compounds of the aromatic series.

Carbonisation chemistry was then characterised by the uncontested monopoly of the supply of raw materials to the industry which was dominated by the chemistry of the aromatic compounds.

Tar and benzole expansion between the wars

Stimulated by the requirements of the armies during the 1914-18 war, the tar and benzole industry entered on a period of rapid expansion in all the countries which had an extensive chemical industry.

During the same period a new branch of carbonisation chemistry was opened up: the chemical utilisation of the constituents of the various gases derived from coal (coal gas, water gas and synthesis gas).

Hydrogen from coal

As long ago as 1913, Germany had successfully developed the synthesis of ammonia on the industrial scale from nitrogen and hydrogen.

The nitrogen was obtained from the air. Several processes were available for the industrial production of hydrogen. Georges Claude, who by about 1918 had also achieved the synthesis of ammonia under very high pressure, proposed to extract hydrogen from coal gas by subjecting it to partial liquefaction so that only the hydrogen remained in the gaseous state. A rough fractionation of the liquid portion enabled a so-called methane fraction (70 to 80% of methane, with carbon monoxide and nitrogen) to be separated, as well as an ethylene fraction (35 to 40% of ethylene), which also contained homologues of methane.

The process proved to be economically sound and was thus of interest to the coke-oven plants which then had available large amounts of excess gas that they were obliged to burn to waste in flares, because the distribution of gas under pressure through long-distance mains was still in its infancy, and the gas industry remained quite separate from the coke-oven industry.

An industry for the production of synthetic ammonia and of ammoniacal fertilisers (ammonium sulphate and ammonium nitrate) thus arose, about 1925, in the vicinity of the coke-oven plants and has expanded considerably up to the present day, along the same lines, mainly in the coal-producing countries of Western Europe (France, Belgium, Holland and Germany).

Utilisation of ethylene

At the same time, the chemical utilisation of the ethylene contained in the ethylene fraction was developed and the first factory for the production of synthetic ethyl alcohol, by the hydration of ethylene according to the method of Berthelot, came into operation in France, at the Béthune mines, in 1926.

Some ten years later, industrial interest in ethylene oxide, glycol and their derivatives—the numerous applications of which are well known (as solvents, anti-freeze products, detergents, etc.)—induced certain carbochemical factories to employ part of their ethylene for the synthesis of these substances.

Quite recently (since 1954) the solid polymer of ethylene, polythene, a plastic which possesses remarkable properties, has been produced in France by a carbochemical factory from pure ethylene—extracted from coke-oven gas—which is compressed to 1,500 atm. in presence of traces of a gaseous catalyst.

Styrene, a raw material for synthetic rubbers (buna, GR-S, etc.) and well-known synthetic resins (polystyrenes) is also to be produced in France very shortly by a carbochemical factory, using only raw materials supplied by the coke-oven plants: benzene and ethylene.

Dichloroethane, obtained by the action of chlorine on ethylene, and employed both as a solvent and as a raw material for the production of vinyl chloride, is now produced by the French carbochemical industry.

Concentration of the ethylenic fraction yields, as residues, considerable quantities of ethane which can be converted into ethylene and propylene for use in syntheses.

Methane as a chemical raw material

Methane, a residue from the extraction of hydrogen and of the ethylenic fraction, was also not long in finding chemical applications; when treated with oxygen or with steam it is converted into a mixture of carbon monoxide and hydrogen known as synthesis gas because it readily lends itself to various syntheses which are mentioned below.

More recently, methane has shown itself to be of value as a raw material for the industrial production of substances such as acetylene (by oxidising cracking of the methane molecule) and hydrocyanic acid (by the combined action of oxygen and ammonia on methane); both these products will shortly be manufactured by French carbochemical factories, one of which will also undertake the synthesis of acrylonitrile (by the action of hydrocyanic acid on acetylene) and of its derivatives such as the acrylates (by the alcoholysis of acrylonitrile).

Acrylonitrile is the raw material for certain special synthetic rubbers (*Perbunan*) and new artificial textile fibres having properties closely similar to those of wool (*Orlon*). It is also well known that acrylates are employed in the manufacture of varnishes and artificial leathers and that polyacrylates are typical 'soil conditioners,' the use of which in agriculture, still in the early stages, is likely to have important developments.

Hydrogen sulphide

Even hydrogen sulphide, an evil-smelling impurity in coal gas, the removal of which is a statutory obligation, is recovered nowadays and utilised, after combustion to sulphur

Carbonised agglomerates

(Concluded from page 307)

The strength of the agglomerates so far produced may be inadequate for commercial handling. Strength is closely related to apparent density: the agglomerates at present being produced have an apparent density of 0.45, whereas low-temperature cokes on the market have a value of about 0.75.

On burning the carbonised agglomerates in an open fire they were found to ignite easily; the fire recovered quickly after refuelling and appeared to evolve little smoke.

Copies of the B.C.U.R.A. annual report may be obtained, price 10s., from the Liaison and Publications Officer at Randalls Road, Leatherhead, Surrey.

dioxide, for the manufacture of sulphuric acid.

This concludes our brief summary of the numerous direct chemical applications which have arisen from the liquefaction of coal gas, originally designed for the recovery of the hydrogen required for the synthesis of ammonia.

Water gas—synthesis gas

In addition to the gas obtained by the distillation of coal, the carbochemical factories produce, on an industrial scale, either from coke, or directly from certain coals, or from methane—by the combined action of air (or oxygen) and steam—mixtures of carbon monoxide and hydrogen, known as 'water gas' (equimolecular mixture) or 'synthesis gas' (1 molecule of carbon monoxide to 2 molecules of hydrogen) which have important chemical applications.

A New Building Material from Coal Mining Waste

A new type of lightweight concrete making use of a hitherto wasted by-product of coal mining, is now being produced at a factory at Stein, in the Dutch Province of Limburg. The raw material is cerolite or wax stone, a stone-like material mainly consisting of aluminium silicates which is interspersed in the coal extracted from the Limburg mines.

Wax stone has a grain size of less than 10 mm. and, being extracted from the same mine, is of practically constant composition. At the factory, the raw material is first burned down at a high temperature and in the presence of a strong air current so that no extraneous fuel need be added. During this process, the grains agglomerate into a cake, all traces of sulphur contents and combustible substances are removed, and the material expands owing to the escape of the gases so that it becomes highly porous. After cooling down, the material is broken and screened into three standard grain sizes (fine, medium and coarse). None of the remaining ingredients is soluble in water or harmful to steel, plaster, timber, lead, mastic or other building materials.

The material has a low volume weight, constant composition, high mechanical strength, good insulating properties and heat resistance.

A description of the raw product, the production process and the chemical and physical properties of *Hollith* is given by civil engineer G. J. Hamer in the Dutch journal *Cement* of April 1956.

COMPLETE GASIFICATION

Full-scale Trials in Britain

In the carbonising industries, gas for use as a fuel or for chemical synthesis is produced in gas retorts or coke ovens with coke as a necessary co-product. Shortage of good coking coals has led to efforts to develop processes in which gas can be obtained from other types of coal by complete gasification, eliminating the coke-forming stage. A large-scale complete gasification plant which has been installed at the Kensal Green (London) gasworks of the North Thames Gas Board is described in this article.

ALTHOUGH numerous examples of complete gasification plants incorporating the *Gas Integrale* system have been built on the Continent, the Kensal Green installation is the first plant built in accordance with that system in the United Kingdom.

The plant comprises essentially a generator on which is superimposed a coal pre-distillation shaft, and operates on the well-known blow-and-run principle. By the use of oil carbureting equipment the calorific value of the gas made can be varied from about 330 up to over 500 B.Th.U./cu.ft.

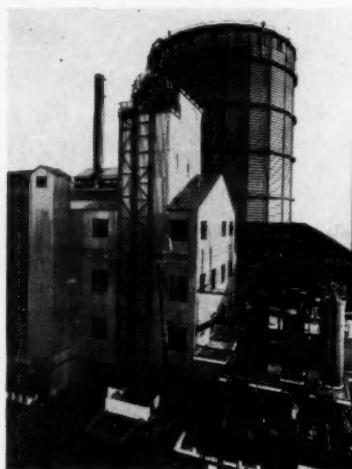
Grouped round the generator itself are the principal ancillary vessels—namely the regenerative steam superheater, tar fixing chamber, carbureting and oil fixing chambers, hydraulic seal and waste-heat boiler. The air blower, gas exhauster and pumps are separately housed, the gas-cleaning equipment being situated on the pumphouse roof.

Arrangement of plant

The lower portion of the generator resembles in most respects a modern water-gas generator and incorporates a low-pressure jacket boiler with separate steam drum. The rotating grate is of the dry-sealed type, allowing high blast pressures to be used, and delivers ash and clinker into two pockets which are emptied once a shift.

Surmounting the generator is the refractory-lined pre-distillation shaft, in which the descending coal is carbonised by the sensible heat of the rising water-gas produced in the lower gasification zone. This shaft is divided into sections by hollow radial walls through which the blow gases circulate during the blow period, so providing a further supply of heat for carbonising the coal.

The regenerative steam superheater and the tar fixing, carburetting and oil fixing chambers are all refractory-lined steel vessels fitted with conical bases for dust removal. Except for the carburetter, which is empty, these



External view of plant showing gasification house and gas-cleaning plant.

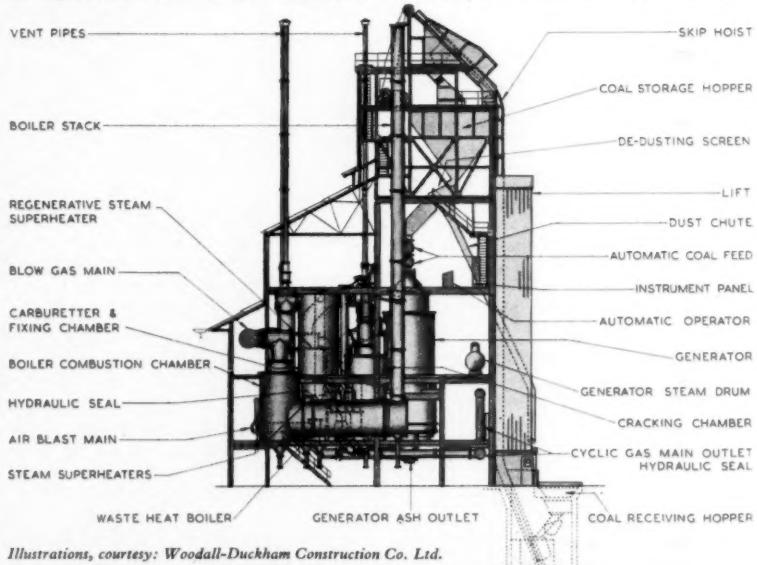
vessels contain chequerwork of special design. The hydraulic seal, which has a conical bottom to facilitate cleaning, incorporates a bell which is lowered

during the blast period, so providing an additional forward seal.

Operation

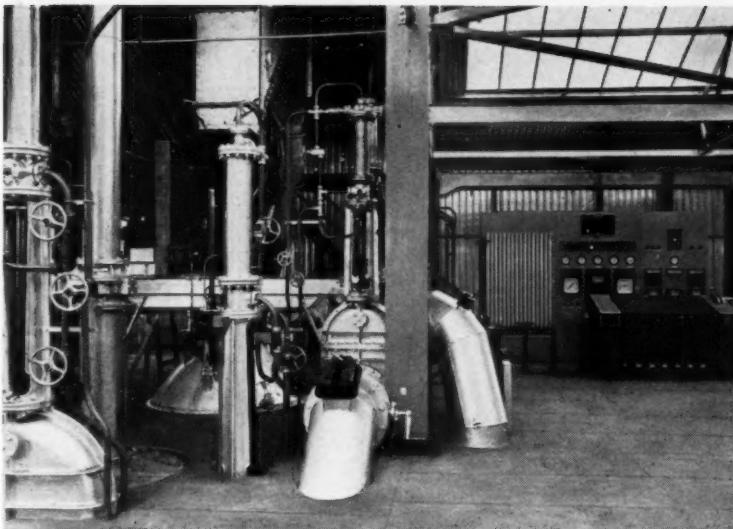
The plant is capable of being operated on either an up-run or a back-run cycle. In either case there is a blow period during which air is forced beneath the grate, and blow gases are burnt in the usual way with secondary air to heat the ancillary vessels, the combustion being completed with tertiary air just before the waste-heat boiler.

When employing an up-run cycle the regenerative steam superheater is in service, and the run period commences with the admission of steam to the base of that vessel; the highly superheated steam, at a temperature of over 700°C., is then led from the top of the superheater through a refractory-lined main and admitted to the generator below the grate. The water gas so formed passes up the pre-distillation shaft, imparting its sensible heat to the column of coal, and leaves



Illustrations, courtesy: Woodall-Duckham Construction Co. Ltd.

Diagram showing arrangement of complete gasification plant.



Generator top level showing the hydraulically operated gas valves with the generator coal charger behind.

the generator vessel at the top, carrying with it the volatile matter of the incoming fuel. When no carburetting is being practised the crude gas passes direct to the hydraulic seal and away to the gas-cleaning plant. If, however, carburettion is required, the gas enters the tar fixing chamber where it is reheated to a suitable temperature before meeting the oil sprays in the carburetter; the oil vapours are then fixed in the chequers of the fixing chamber before the gas passes to the hydraulic seal.

If, however, a back-run cycle is employed, the regenerative steam superheater is not in use. In this case the up-run part of the cycle is similar to that described before, except that the process steam is admitted directly beneath the grate. During the back-run, which follows the up-run, the steam enters the generator at the top of the gasification zone after being highly superheated in the fixing and carburetting vessels, the water gas made leaving the generator at the base.

Control devices

Special provision is made to ensure that volatile matter which continues to be evolved from the coal in the pre-distillation shaft during the blow-and back-run periods does not travel downwards and become either lost with the blow gases or cracked in the fire. For this purpose a small bypass on the top gas outlet is kept open during these parts of the cycle.

The plant is completely automatic in operation and is provided with comprehensive instrumentation. An

interesting feature is the coal-feeding device, comprising a pair of rotating drums, which automatically maintains the coal level inside the generator vessel.

Turning to the gas-cleaning equipment, the inclusion of a hot-gas electrostatic detarmer at the outlet from the hydraulic seal is noteworthy and is designed, in conjunction with an up-to-date tar and liquor system, to minimise the volume and contamination.

tion of the effluent produced. The tubular-type gas condenser is followed by a cold gas detarmer and ammonia washer.

Operating results

The plant came into operation in October 1955 and various trials have been carried out on the gasification of different types of coal. So far the plant has demonstrated its ability to produce more than $2\frac{1}{2}$ million cu. ft. of gas of a calorific value up to 500 B.Th.U. in 24 hr. from East Midlands low-rank coal with a swelling number of 1 to 2 and containing approximately 37.5% of volatile matter.

There is still much interesting work to be done on the gasification of different types of coal to determine the range of raw materials available to this type of plant. Trials will continue, too, on the possibilities of increasing the output and it is hoped that the information from these trials will be made available in the form of a paper to be presented to the industry in due course.

Main contractors

Woodall-Duckham Construction Co. Ltd. were the main contractors for the complete installation.

The International Furnace Equipment Co. Ltd. were responsible for the design and supply of the specialised G.I. system equipment.

Liquid Fuels in South Africa

NEW OIL-FROM-COAL PLANT CHANGES PICTURE

UNTIL the establishment of the Sasol oil-from-coal plant, the only indigenous sources of liquid fuels in South Africa which had been exploited were torbanite (which is mined near Ermelo), by-products of the sugar-cane industry (alcohol), and coke-ovens and gasworks (benzole). The total amount of liquid fuels thus becoming available represented only about 1% of the country's requirements. The balance has been secured by imports.

The existence of the refinery at Durban to process imported crude oil has many advantages, but insofar as types of liquid fuel are concerned, it does not appear that it will alter the present position materially, since it has been designed mainly to produce the types previously marketed by the Vacuum Oil Co. of South Africa.

The Sasol oil-from-coal project will, on the liquid fuel side, produce petrol and diesel oil only. The estimated production of products, according to

the company's annual report, will be 71 million Imp.gal./year.

Sasol changes the picture in that its raw material is indigenous coal. The Durban refinery has been in production since 1954 and Sasol was originally expected to be in service in the same year, but various postponements have pushed the date back. It is now hoped to have the plant in commercial production during the current year, but with the technical faults that have cropped up recently it is still uncertain when commercial production will begin. Thus it remains for the future to show what the influence of these two undertakings will be on the South African fuel position and what future developments there will be regarding the variety of liquid fuels they may produce.

In South Africa contemporary vegetable growth, such as timber, has only restricted value as fuel for industrial application, so that it has not merited

any serious or extended consideration. Lignite occurs in the Khysna and Van Rhynsdorp districts, but no exploitable deposit has yet been located. The reserves of torbanite and oil shale, although useful, are also small in comparison with those of coal.

It has recently been pointed out by the Fuel Research Institute of South Africa that the distribution of energy resources over the world determines the pattern of world trade. Two-fifths of all international trade comprises the transport of fuels—particularly petroleum products—from producing countries to areas which are deficient in such fuels. Nearly all of the remaining trade consists of the interchange of raw materials (from countries lacking in sufficient fuels to convert their raw materials) for manufactured products (from countries possessing adequate fuels to process raw materials).

It is calculated that South Africa has about 97% of the coal resources of the African continent. Certain losses in mining have to be considered and, should an overall figure of 70% extractability be assumed, then the total mineable coal reserves of the Union will amount to some 52,410 million short tons. The start of a continuous and steady advance in coal production in the Union coincided with the lower point of the Great Depression, with the founding and beginning of a steel industry (Isco) in the Union, and therefore with the industrial awakening of South Africa. The present consumers of coal in the Union can be divided into five groups: mines, railways, power generation, export and bunkers, and industrial and domestic consumers.

For full industrial development, South Africa must, of course, ensure the adequacy of other natural resources, such as water, and of materials of construction—both metal and non-metal—but all of these are relatively durable and/or can be re-used often, while coal, and all fuels for that matter, can be used once and once only. All the facts therefore indicate that the Union must to a large measure achieve independence as regards liquid fuels. This is possible by (a) intensive prospecting by drilling for petroleum in the geologically promising areas of the Union, and (b) the erection of synthetic fuel plants to keep pace with increasing requirements. It is confidently expected that the Sasol plant which has recently been completed will pave the way for considerable expansion in this field in the Union and perhaps also in Southern Rhodesia.

Coal Treatment and Chemical Engineering

INTERNATIONAL PROBLEMS

Here, to wind up our survey of coal as a raw material, we present a summary of the international conference on 'Chemical Engineering in the Coal Industry' which was held at the Coal Research Establishment of the National Coal Board at Stoke Orchard, near Cheltenham, recently. At Stoke Orchard, research is concentrated on producing better fuels and the central task may be described as using the methods of modern chemical engineering in new processes to treat coal. To this British centre came scientists with similar aims from many parts of the world, to discuss the special problems which arise in the various coal treatment processes. Our summary includes brief extracts from some of the papers.

CONTROLLED OXIDATION OF COAL

Economics to be considered

The industrial oxidation of coals is frequently proposed as a means of reducing their caking properties. This point was discussed in the first paper by Monsieur A. F. Boyer (Groupe Carbonisation, C.E.R.Ch.A.R., Verneuil, France), who then went on to give an account of industrial applications and of semi-industrial trials in France as well as laboratory work on oxidation.

One interesting industrial application in France is the manufacture of briquettes by the *Anthracine 54* process. The oxidation is used here as a means of reducing the smoke formed when the briquetted balls are burnt. This production process is in full development.

The briquettes are made from a dry steam coal with approximately 10% of volatiles, using pitch. The oxidation process resembles that used at Carmaux, but the plant is more modern. The briquettes are loaded into wagons with a grid bottom, these wagons running in a tunnel furnace. Hot oxidising gases are blown in from the bottom; the temperature of these gases is adjusted so that it does not exceed 320 to 350°C. after having passed through the layer of briquettes. If the reaction gets out of hand, water spraying is resorted to.

The oxidation takes about 4 hr. It is necessary to cool off the briquettes

before they are exposed to the air. The above treatment is much more effective than would be the maintaining of the briquettes at 350° in the absence of air.

In concluding his contribution, M. Boyer pointed out that oxidation of coal before carbonisation can only be justified in a small number of cases.

If it is intended to carry out carbonisation of the normal type, to produce metallurgical coke, it is almost always more economical to reduce the fluidity of the coal (should it happen to be excessive, which is very rare) by incorporating non-fusible constituents in the mixture (e.g. low-volatile coal, coke dust, semi-coke, etc.), or even constituents which are both non-fusible and oxidising (non-fusible coals with a high volatile content, lignites, ferric oxide powder, etc.); these latter additives have an even stronger effect. Inert constituents of suitable particle size have the additional advantage that they reduce fissuration.

It was in this way that the Lorraine coalfield was able to solve a problem connected with the carbonisation of briquettes (*Tetralor*). To eliminate any deformation of the briquettes during heating, they were made of a mixture—in suitable proportions—of high-volatile coking coal (slightly fusible, with 36 to 38% of volatiles and 9 to 10% of oxygen) and dry high-volatile coal (non-fusible, with 37 to 39% of volatiles and 11 to 12% oxygen).

Preliminary oxidation would, perhaps, be necessary before carrying out semi-carbonisation in a fluidised bed, when treating coking coals, but, as we have seen, this is not quite definitely established as yet.

It seems probable that the most simple and most economical technique for oxidising coal fines is to heat them to approximately 300°C. by means of oxidising gases in a fluidised bed. This treatment is economical, because preheating is carried out at the same time (this raises the calorific value of the semi-carbonisation gas) and also, possibly, de-dusting (which facilitates the condensation of the tars).

Finally, it has been shown that it is possible to dry coals which are very sensitive to oxidation, on an industrial scale, without changing their coking properties.

FLUIDISED OXIDATION OF COAL

Automatically controlled pilot plant

The National Coal Board are already large-scale producers of solid smokeless fuel at their coke ovens and by the manufacture of *Phurnacite*. The capacity of the South Wales *Phurnacite* plant is being doubled. This will make available a further 300,000 tons p.a. of a smokeless fuel which is of exceptionally high quality for domestic boilers and closed stoves. This fuel is made by briquetting a pitch-coal mixture and carbonising the resulting briquettes. Further extensions of *Phurnacite* production may prove difficult, since the supply of suitable coal is limited. These considerations were mentioned by Dr. G. I. Jenkins, of the Coal Research Establishment, Stoke Orchard, who pointed out that, in order to extend the range of suitable coals, it is necessary to destroy the caking properties before subjecting them to briquetting and oven carbonisation.

It is well known, Dr. Jenkins went on, that a mild oxidation will reduce the caking and swelling properties of a coal. The coal which is used for the briquetting process is of small-particle size. Hence, since the oxidation process consists in raising the temperature of a finely divided solid and contacting it with a gas containing oxygen, it was considered that fluidisation would be the ideal method of carrying out the reaction.

Data obtained from the operation of the small fluidised unit enabled a larger pilot plant to be designed and erected.

In order to avoid vessels of excessive

diameter, the heating was carried out in two stages. The first vessel was designed to enable the coal temperature to be raised to about 200°C. and the second vessel designed to complete the heating to temperatures within the range 250 to 450°C. The design basis was for a nominal oxidation capacity of 1 ton/hr. The preheating reaction and cooling vessels operate on the fluidised-bed principle.

The plant is fully instrumented and is controlled from a central control panel. The comprehensive automatic control and recording system enable accurate data to be obtained. The control of the reactor temperature is of interest, since two temperature controllers are used. The first temperature controller maintains the fluidising gas at a temperature slightly in excess of that required. The second temperature controller maintains the desired reaction temperature by the introduction of water into the fluidised bed.

The pilot oxidation plant has been operated for long periods and over a wide range of temperature and coal residence times. So far, the investigations have been confined to coal with a volatile content of approximately 16%. On the scale of about 1 ton/hr. it has been established that this coal may be rendered suitable for the manufacture of carbonised briquettes. The process is simple to operate, amenable to automatic control and is not critical with respect to operating variables. Particular attention has been paid to the heat balance and the oxygen requirements, since these are of prime importance in the design of commercial oxidation units.

INVESTIGATIONS INTO THE CARBONISATION OF BRIQUETTES IN GERMANY

Special pitch used as binder

Problems of briquetting technique were discussed by Dr.-Ing. Wilhelm Reerink, of the Steinkohlenbergbauverein, Essen, Germany. He included some discussion of the experience that has been gained in carbonising briquettes made from non-caking coals (sometimes used as diluents) and finally dealt with carbonisation tests on briquettes manufactured from a mixture of coal and ore.

The Pluto chemical works of the Rheinische Bergbau A.G., in Gelsenkirchen have been occupied, in the last few years, with developing a special pitch—derived from bituminous coal tar—for use in briquetting. This special pitch contains a

certain proportion of cyclic compounds and a lower viscosity and better wetting properties are obtained with this product than in the case of normal tar pitch. One of the principal advantages of using this material lies in the fact that it eliminates the drying of the material to be briquetted, since even wet raw materials with a considerable moisture content can be briquetted without difficulty by using this type of pitch. At the same time, the quantity of binder required is from 25 to 35% less than usual, so that the fact that the price of this special pitch is somewhat higher than that of ordinary pitch is more than compensated by this saving. This product is used in the Ruhr in a plant which manufactures 'ovoid' briquettes from bituminous coal.

It is noticeable that the process of briquetting itself remains, to a very large extent, unexplored, and a large experimental installation for the briquetting of bituminous coal is being erected at the present time at an idle colliery in the Essen district. This installation will permit manufacture of 2 to 10 tons/hr. of briquettes, working under operational conditions with the most modern machines and devices and using various types of press. The experimental plant will be completed at the end of this year.

HOT BRIQUETTING

Overcoming practical difficulties

One of the most important methods of producing a smokeless fuel to satisfy the increasing demand for such fuels in Britain involves briquetting of the coal and subsequent carbonisation of the briquettes. This process is applicable in Britain without modification only to a very limited range of coals, and in developing the process so that other coals may be utilised it has been necessary to pretreat many coals either by mild oxidation or partial carbonisation.

In both these pretreatments the coal is heated to temperatures varying from approximately 300 to 600°C. A further heating cycle is involved when the briquettes are subsequently carbonised at temperatures usually above 600°C. The briquetting stage is thus interposed between two heat treatments.

If conventional briquetting at about 80°C. is followed, employing, for example, coal-tar pitch as the binder, the briquettes must be cooled to near ambient temperatures to permit the pitch to set and impart sufficient strength to the briquettes for mech-

anical handling to the carbonising unit. In this final treatment the briquettes have to be reheated through this temperature range. The overall thermal efficiency of such a process is obviously low. It can be considerably improved, however, if the briquetting operation is done at or near the pretreatment temperature, provided the briquettes are sufficiently strong at these temperatures to withstand handling in the subsequent carbonisation stage.

These points were made in the introduction to a paper by Mr. D. H. Gregory, of the Stoke Orchard establishment. Recent and, indeed, current work at the Coal Research Establishment of the N.C.B. indicates that the practical difficulties of briquetting within the plastic range of the coal may be overcome by the addition of a fluxing agent such as coal-tar pitch to the coal, the object of the flux being to make the coal more fusible over a wider temperature range. It has also been shown that the addition of the pitch as a flux does not alter the decomposition temperature of the coal. The nett effects of introducing the flux are, therefore, that the range of coals which soften before decomposition is widened and that the permissible briquetting temperature is increased.

One application of hot briquetting is in the briquetting of oxidised coal and, from briquetting experiments, on laboratory and small experimental plant scales, it is concluded that the variables in the hot briquetting of oxidised coal are the flux content, the briquetting temperature and the degree of oxidation in the coal.

Another application of this hot technique is in the briquetting of semi-coke.

INDUSTRIAL TREATMENT OF LOW-TEMPERATURE CARBONISATION TARS

Corrosion problems encountered

M. J. L. Sabatier, of the Charbonnages de France, spoke on the industrial treatment of low-temperature carbonisation tars and on the applications and market possibilities of the products obtainable. He pointed out that the industrial treatment of low-temperature tar presents its own characteristic difficulties; these are due to the greater thermal sensitivity of the tar and to the corrosive properties of certain fractions.

In addition, the refinement of the different products involves technical and commercial problems which are very different from those already



During an Open Day held at Stoke Orchard in connection with the conference, Dr. J. Bronowski, Director of the Establishment, demonstrates a model sand-carbonisation plant to Sir Harold Hartley, C.B.E., F.R.S. (past president of the Institution of Chemical Engineers). Dr. Bronowski's summing up of the conference was reported in our last issue (page 259).

known in connection with coke-oven tar; these originate in the differences in nature and properties which exist between the corresponding fractions of the two types of tar, although there is also the influence of the fact that hitherto very small quantities have been put on the open market.

The crude tar—containing 2% of water—is distilled at Marienau in a conventional unit, comprising a plate column fed from a pipe still. The choice of the materials for the columns and for the pipe still raised certain problems in connection with corrosion; these difficulties were solved by the use of stainless steel (18% Ni, 8% Cr, 3% Mo) in the 'threatened' elements—the parts in contact with liquid fractions at a temperature above 230°C. The maximum temperature on leaving the pipe still is 380°C. and the pressure 4 kg. The column contains 27 plates.

This unit operates—on an average—for 300 days in a year; regular interruptions are made for maintenance, involving from 10 to 12 days per quarter. During these interruptions the pipe still is cleaned by controlled combustion of the deposits, using a mixture of air and steam.

The pitch is discharged in the form of plates, 3 to 5 mm. thick, obtained by spreading out the hot pitch at the end of a rubber conveyor belt, which is sprayed with cold water. This gives a continuous plate of pitch, which breaks up at the end of the belt and is discharged directly into trucks. In

this form the pitch has only a slight tendency to agglutinate and is easily handled. The water content does not exceed 1%.

In the case of low-temperature tars, the industrial secondary treatments hitherto applied are virtually limited to the recovery of phenols, which occur in particularly large quantities.

The products obtained from the primary distillation and the secondary treatments fall into three main groups:

Phenolic products, representing about 10% of the tar. Continuous rectification is capable of giving a number of fractions which are readily marketable, particularly in the phenol plastic industry: phenol 90%, and m-p-cresols containing 40 to 45% of meta-cresol. Discontinuous rectification makes it possible to work up the pure products (phenolic acid and orthocresol), concentrated products (meta-paracresol with more than 50% of meta-cresol) and fractions which are standardised for particular uses (cresylic acids). In addition, it allows the preparation—at the request of the chemical industry—of xylenols 1-2-4 and 1-2-5 and xylenol 1-3-5.

Oils. The low-temperature tar oils have special characteristics which distinguish them from high-temperature tar oils and which make it possible to use them for particular applications.

Pitch from low-temperature tar has physical characteristics which are intermediate between those of coke-oven tar pitch and those of petroleum bitumens. It has various uses and in every case is competitive with petroleum bitumens.

Monsieur Sabatier concluded that the profitable use of the products obtained from low-temperature tar must follow a different pattern from that adopted with high-temperature tars. Further progress in the knowledge of the specific characteristics of this tar—and also of the methods of treatment—may open up new possibilities; in this field, the British low-temperature tar industry, which has done pioneer work, is continuing to make valuable contributions.

THE STUDY OF TARS OBTAINED IN FLUIDISED CARBONISATION

High phenol content

The study of tars obtained in fluidised carbonisation at Stoke Orchard was discussed by Dr. G. H. Watson and Mr. A. Fowler Williams. The relatively high proportion of phenols is an important feature of the tar, although the amount of ordinary

phenol in it was only about 0.2% and the amount of potentially useful phenols (boiling below 220°C.) only about 4%. The value of the higher phenols present would be greatly increased if they could be converted in high yield to lower-boiling products.

As in the case of the phenols, a large proportion of the neutral oil was high boiling (some 70%, b. 350°C.). Its market value would no doubt be considerably increased if it could be economically converted to lower-boiling material.

The work reported was of necessity incomplete. An increase in knowledge of the composition of the tars requires a much finer fractionation of the starting material than was achieved; this will be attempted, not only on the lines already described, but by the use of such techniques as partition chromatography, thermal diffusion and so forth.

SEMI-CARBONISATION BY FLUIDISATION

French plant of 10 tons hr. capacity

The semi-carbonisation of coal—that is to say, its carbonisation at low or medium temperature—gives rise to three chief products: semi-coke, tar and gas. The approach to semi-carbonisation varies, therefore, according to which product is considered the most important. In work that has been carried out at the Station Experimental de Marienau, France, and which was described in a paper by Messieurs A. Peytavy and P. Foch, semi-coke is the main product considered, since a product is being sought which can be used as an additive to improve the quality of coking blends.

The paper was presented by M. Foch, who summarised the objectives of the work at Marienau and described the various possible solutions to the industrial problems. For various reasons, the design of an industrial unit with a capacity of 10 tons/hr. was decided upon, with internal heating by means of an air blast. When this process had been adopted, decisions had to be made on various other points. It would, in fact, be possible to contemplate carrying out the preliminary preheating of the coal to about 300°C., that is to say, up to its thermal threshold, and of the air to 500°C. Calculation shows that roughly half the heat required for carbonising the coal at 800°C. would thus be supplied from outside the carbonisation apparatus. Consequently, twice as much coal could be car-

bonised with the same flow of air, which would improve the quality of the gas and would make it possible to operate with smaller apparatus. Since it was necessary to extrapolate the results in a proportion of 1 to 10 in order to pass from the present unit to an installation which might be considered the standard industrial unit, the semi-carbonisation oven could be extrapolated in a ratio of 1 to 5, which is obviously much simpler.

Another aspect of the question is a purely technological matter. Hitherto, work had been done with coal dried to a moisture content of 3 or 4%. Drying had been regarded, by implication, as an essential preliminary operation. Attempts could be made to eliminate it in either of two ways:

(a) By charging the air oven directly with wet coal. This was tested once over a period of about 12 hr. With the exception of a few minor difficulties of a practical nature, which do not appear insoluble, the installation operated in a steady manner. This solution results in a remarkably simple unit, since it comprises only a single apparatus. On the other hand, the gas is of rather poor quality, but

nevertheless remains utilisable (900 kcal./cu.m.). Finally, the apparatus must be relatively large since the amount of the air to be blown per ton of coal is greater than in the case of dry coal. This solution can therefore be considered, but it is probable that the following method will prove to be better.

(b) By carrying out the drying at the same time as the preheating. Charging is a less difficult operation than in the previous case, because there is no risk of obstruction owing to condensations of tar. It is highly probable that the two operations can be carried out simultaneously and a check test is to be undertaken. Investigation of the industrial unit is being turned in this direction at the present time.

Lastly, passing from an apparatus giving 1 ton/hr. to a unit producing 10 tons/hr. of semi-coke raises problems of extrapolation which must not be underestimated. In particular, an endeavour is being made to avoid too large an increase in the height of the bed which would involve apparatus of an unduly large size, as well as very high pressures for the blast. This problem is now being investigated.

British Patent Claims

Distillation columns

A distillation column packing for promoting efficient contact between the liquid and vapour phases comprises horizontal troughs, arranged in series at different levels in the column, the convex walls of which form throats between the troughs where mixing of liquid and vapour is facilitated. The troughs are perforated so that liquid collected in catchment thereof is ejected by hydrostatic liquid pressure.—749,900, British Petroleum Co. Ltd. (formerly Anglo-Iranian Oil Co. Ltd.).

Reaction furnaces

A furnace for gaseous chemical reactions (e.g. the oxidation of CH₄) consists of a series of parallel contact tubes for the reaction mixture, which tubes are lodged in a heating-gas channel transversely to the flow of heating gas, the heating-gas channel having two parallel side channels, one each side, both opening at one end into the central channel and provided at the other end with an inlet for heating gases delivered by a fan, the suction side of the fan(s) being connected with the outlet end of the central channel so as to impel the heating gas in a circuit through the

central and side channels.—750,084, Bergbau-A.G., Neue Hoffnung (Germany).

Purifying water-insoluble solids

Ionic impurities are removed from water-insoluble solid particles (e.g. silica-alumina gels for cracking catalysts) by introducing the particles with ion-exchange particles of greater particle size and/or density into a mixing zone, passing water through the mixing zone into an upper disengaging zone, the velocity of the water being controlled so as to cause upward passage of the water-insoluble particles and falling back of the ion-exchange particles. The purified water-insoluble particles are then removed from the top of the disengaging zone and the ion-exchange particles removed from the bottom of the mixing zone.—750,104, Esso Research & Engineering Co. (formerly Standard Oil Development Co.) (U.S.).

Separation of acid mixtures

A mixture of saturated and unsaturated acid compounds is separated by crystallisation from an organic solvent comprising (1) a primary separation at a relatively low tem-

INDUSTRY REPORTS . . .

perature when the saturated and mono-unsaturated fractions crystallise leaving the poly-unsaturated compounds, in solution, and (2) a separation of the obtained crystals (in the above solvent) at a higher temperature when the saturated fraction only crystallises.—750,045, *Texaco Development Corporation (U.S.)*.

Production of nitrogen-containing atmospheres

An apparatus for producing N₂-containing atmospheres (e.g. for metal annealing), wherein NH₃ and O₂ in a molecular ratio of <4:3 are contacted at elevated temperatures with a metallic Ni catalyst, comprises an inner catalyst chamber (the lower part of which is grid-shaped to retain the catalyst and allow the passage of gas) positioned in a second chamber (open at the top) to form a space between the walls of the two chambers, both chambers being surrounded by a third insulated chamber. NH₃ and O₂ can be introduced into the top of the catalyst chamber and O₂ into the bottom. Means for withdrawing product gas from the bottom of the third chamber and initially heating the catalyst are also provided.—750,234, *Imperial Chemical Industries Ltd.*

Analysis of gases

The detection, or measurement of concentration, of oxygen in other gases (e.g. in lamps, valves, etc.), is effected by adsorbing the oxygen at a galvanic cell cathode and thus producing a current that is a function of the oxygen concentration. The cathode is of material inert to the electrolyte in the absence or presence of oxygen, and the anode is of base metal readily attacked by electrolyte, but only in the presence of oxygen (parent patent). The electrolyte is retained by capillary action in a porous carrier, interposed between and in contact with an open-work cathode and the anode.—750,254, *Mond Nickel Co. Ltd.*

Textile wet-processing machine

In a machine (e.g. for dyeing yarn packages) having a closed liquid circulatory system, an open-topped liquid container outside the circuit is connected to the system at the suction side of the circulating pump to provide a static pressure in the circulating liquid.—744,418, *S. Pegg & Son.*

The above are abstracts reproduced from the weekly Patents Abstracts Journal by permission of the Technical Information Co. The complete specifications can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2, price 3s. each.

New fields for French firm

In his annual review of the affairs of L'Air Liquide (France) the chairman, M. Jean Delorme, mentioned some new branches of activities of the company apart from the production of gases. These include the production of heavy water, the utilisation of liquid oxygen and of hydrogen peroxide for jet propulsion purposes, and the manufacture of polythene.

High-energy chemical fuel project

The establishment of a division to produce nuclear fuel and nuclear reactor cores is among the activities mentioned in the report of the Olin Mathieson Chemical Corporation (United States) for the six months ended June 30. Negotiations were also completed with the U.S. Air Force to build a \$36-million plant to produce a new high-energy chemical fuel developed by the corporation for use in missiles and aircraft engines.

Industrial chemicals

Plans to develop a range of industrial chemicals at an 83-acre site at Widnes, south Lancashire, were announced in the circulated statement of Mr. F. G. Pentecost, chairman of A. Boake, Roberts & Co. (Holding) Ltd. (United Kingdom). Contracts have already been signed for the first project, a modern plant of large output for the manufacture of phthalate plasticisers. This plant is expected to be in operation towards the end of 1957.

Other projects include aromatic and fine chemicals, and flavouring materials, etc.

High-nickel alloy plant acquisition

Capital expenditures of \$11,968,000 during the first six months of 1956 are recorded by the International Nickel Co. of Canada Ltd. in its interim report. This includes capital expenditure of \$4,165,000 by the subsidiary, Henry Wiggin & Co. Ltd., for the acquisition of the specialised high-nickel alloy fabricating plant in Hereford, England, which that company designed and erected and which has been operating since 1954 under arrangement with the United Kingdom Ministry of Supply.

Changing scene in petroleum equipment manufacture

The changing scene in the petroleum industry is discussed in the annual report 'Iraq Oil in 1955,' in which it is pointed out that much of the oil-

producing equipment for the Middle East and the plant for refinery construction is now being manufactured in Western Europe, thus creating there a new industry which was largely the exclusive domain of United States' manufacturers before the war.

Platinum expansion

The marked increase in the use of platinum, particularly in the oil refining industry, was referred to in the annual review of Mr. Hay W. P. Matthey, chairman of Johnson, Matthey & Co. Ltd. (United Kingdom), who also discussed the company's plans for adding to its platinum refining facilities.

Plans for the transfer to Royston of much of the refining and chemical work now carried on at Hatton Garden and at other branches in London have now been completed, and building work has started on the new site. It is expected that the whole move will be completed by the autumn of 1957.

The company's need for a larger platinum refinery of more modern design is underlined by the recently announced intention of Rustenburg Platinum Mines Ltd. to increase very substantially its output of platinum group metals, and the timing of the Royston project was in keeping with Rustenburg's development programme, Mr. Matthey said. The company has been entrusted from the beginning, in 1931, with the refining and marketing of the whole output of Rustenburg Platinum Mines Ltd., which on the completion of its present expansion programme will be by far the largest single producer of platinum in the world.

Another development mentioned by Mr. Matthey was Johnson Matthey's acquisition of a majority shareholding in two companies: Lithium Products (Pvt.) Ltd., a small private company operating at Gwelo, Southern Rhodesia, on the treatment of lithium ores to produce lithium carbonate; and Emile Ragout, of Maastricht, Holland, producers of liquid gold and other preparations used in the ceramic industry.

Scientific research

The annual report of the Dechema (Germany) for the year 1955 reveals that a sum totalling approximately D.M.200,000 was expended during 1955 for purposes of scientific research. This sum included grants made from the Max Buchner Foundation, which is managed by the Dechema.

Asbestos Fibres in Gaskets

ASBESTOS, which is mined or quarried, is of inorganic crystalline composition, of a fibrous nature and possessing a very high degree of resistance to heat and flame.

There are two main varieties of asbestos, the most important being white, or chrysotile, which is mined mainly in Canada, Rhodesia and Russia, and the blue crocidolite asbestos found in South Africa. The latter type is highly resistant to strong mineral acids, properties which are put to good use in the manufacture of acid-resisting filter fibres and in the construction of acid-resisting packings. Its general properties are not so good as those of the chrysotile variety, which today is used very extensively in the manufacture of yarns, cloths, packings and jointings covering the whole field of modern industrial sealing and insulating requirements, not to mention the extensive use of asbestos in brake linings for all kinds of motor transport, aircraft brakes and industrial brake and clutch applications.

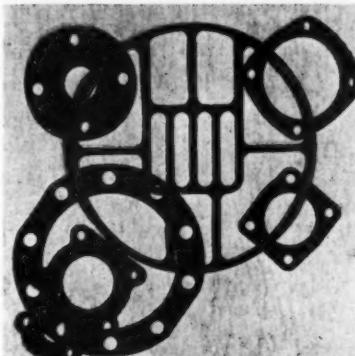
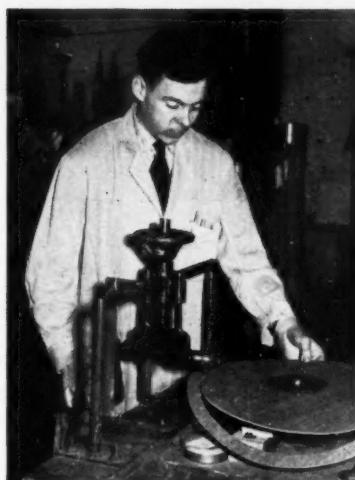
The manufacture of asbestos products is a highly specialised industry, the conversion of the crude mineral into yarns, textiles, etc., calling for a high degree of manufacturing skill combined with long experience. To outline briefly the main basic manufacturing processes, the crude asbestos, as received from the mines, must first be crushed and rolled to separate the fibres. It is necessary to remove foreign matter such as particles of stone and broken rock drills. This is done by means of a centrifugal separator and then by passing over an electro-magnet. The next process, known as 'opening,' further separates and loosens the fibres, leaving the asbestos in the form of a light, fleecy down, with the individual fibres lying in all directions.

In order to make this suitable for spinning, a further important operation is necessary, the purpose of which is to bring the fibres to lie in one direction. This is the elaborate mechanical process known as 'carding,' which converts the mass of fibrous asbestos into sliver, or lightly twisted strips ready for spinning.

The spun yarns are then 'doubled' (if necessary with wire) to the requisite number of plies, after which they pass to the looms or braiding machines.

Manufacture of gaskets.

For the manufacture of proofed asbestos woven gaskets, used for boiler



Specimens of compressed asbestos gaskets for a variety of uses. The large centre gasket is hand cut for use in the oil industry. Above: Cutting a gasket.

manhole and mudhole doors, seals for autoclaves and other vessels, or for joints on pipe flanges which are rough and uneven, or on fragile flanges, the woven cloth is subjected to a proofing process during which a high-grade rubber compound is frictioned into the cloth. The rubber-proofed asbestos cloth, in a tacky state, can now be used for making up proofed rings and tape, by cutting suitable strips and rolling into the desired width and number of plies, the tacky finish securing the required adhesion between the plies.

In the case of rings, a joining is made during the rolling process, and the rings are subsequently flattened and shaped to the required diameter.

The finished joints, or jointing tape, are then french chalked, or given a coat of finest flake graphite which helps to prevent the joint from sticking

to the flange faces when in use, rendering it more easy to remove for replacement.

The manufacture of such joints, and of joints cut from compressed asbestos fibre jointing, is a speciality of Howard Bros. at their works at Wardle, Lancs., where large quantities are produced for use on boilers, pumps, valves and pressure vessels—in fact, every type of equipment requiring a seal against gases, dry heat, steam, water, oil, acids and for a multitude of chemical requirements.

Cut joints for pipelines

In nearly every industry many miles of pipeline are used, and these tremendous lengths can only be made up in short sections and then each section must be joined to its neighbour. This is done by fitting a flange to each pipe between these flanges is almost always required, and this need is well served by compressed asbestos fibre cut joints.

The compressed asbestos fibre jointing from which such joints are cut is made from a combination of asbestos fibre and a suitable bonding agent, the type of bond depending on the ultimate application of the jointing.

The asbestos used in such materials is in the form of extremely fine fibres having a high degree of flexibility, strength and resistance to elevated temperatures. The bond is usually rubber or some type of synthetic rubber and this provides the resilience so necessary to the satisfactory performance of a jointing, and also the resistance to the various liquids, gases, etc., against which the joint must make a leak-proof seal.

Selection of jointing

Various joints are available according to the medium in question, but the thickness of jointing to be used must also be considered. This in turn depends upon the state of the flanges. If these are rough and in poor condition, thick joints must be used, but as a general rule the thinnest jointing which will make a satisfactory seal is the right one.

It should also be noticed that thin jointings are recommended for high-pressure conditions. The method of fitting joints is extremely important, and lubrication of the joint surface with oil, etc., is not to be recommended.

(Concluded on page 334)

PVC Production in Brazil

IN bustling, fast-growing São Caetano, one of São Paulo's outlying industrial districts, Geon do Brasil S.A. constructed its immense plant for the production of PVC resin and, at the beginning of last year, opened its doors to business. Two of Geon's partners are the Matarazzo enterprises and the B.F. Goodrich Chemical Co. of the U.S.

The idea of this enterprise originated when the Matarazzo enterprises sought an economical use for the chlorine produced as a by-product of their caustic soda plant. On the other hand, Goodrich was interested in the growing market for PVC in Brazil, where they were already selling increasing quantities of this resin.

All the raw materials used in the manufacture of the PVC are obtained from domestic sources. They are the very elemental and abundant materials: water, salt, coke and limestone. The manufacturing process starts with hydrogen chloride, obtained from the water and salt, and acetylene from the coke and limestone. The first step is the combining, under the action of catalysts, of the hydrogen chloride and acetylene. The resulting vinyl chloride is then converted to polyvinyl chloride in large polymerisers under the influence of heat, catalysts and modifying agents. To ensure a supply of acetylene—a basic raw material—an acetylene generating plant was built; this was completed at the same time as the PVC plant proper.

The synthesis plant incorporates a high degree of instrumentation and there is a pressurised control room from which the whole plant can be controlled and, in an emergency, shut down if necessary.

Vinyl chloride produced in the synthesis building is piped to the adjacent polymerisation building, which has a three-storey-high refrigeration room. Other buildings include a well-equipped laboratory and drying, packing and warehouse facilities.

Only three American technicians were needed to help set up the plant and they still work with it. All other employees are Brazilian. There is continuous day and night operation of the plant, which employs only 150 persons. Of these, 30 are office workers and the remaining 120 are factory hands—40 for each of the plant's three 8-hr. shifts.

The company's initial registered capital was \$Cr20 million, and was recently raised to \$Cr75 million.

Vacuum-Forming Process for Thermoplastic Sheet

A new vacuum-forming process has been introduced by the makers of a thermoplastic sheet material, who state that this sheet, which is known as Saroy and is extruded from Styron 475 polystyrene, can be deep drawn to an extent hitherto impossible. The new process enables a wide range of products—best described generally as

being both 'large' and 'deep'—to be made more economically, it is said. Some of the uses for the sheeting are: refrigerator liners, baffles and drip trays; advertising display panels; photographic trays; interior signs; television masks, etc.

It has good resistance to alkalis, salts, oil, mineral acids, lower alcohols and water; fair resistance to mineral and vegetable oils; and is generally soluble in aromatic and chlorinated hydrocarbons, esters, ethers and some terpenes.

The manner of producing the thermoplastic sheet is briefly as follows.

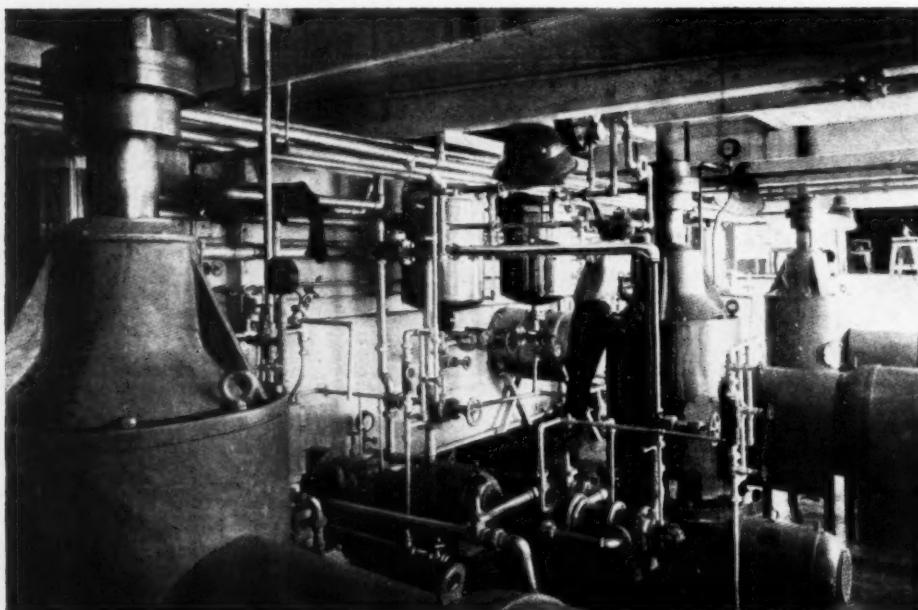
The raw material is fed to the extruder hopper by pneumatic equipment, which adds, as required, a fixed amount of regrind. The hopper is equipped with a high-capacity heater drier, ensuring completely moisture-free granules.

The extruder, driven by a 50-h.p. motor, has electronically controlled, fully variable speed for its 20:1 screw of 4½ in. diameter, specially designed for use with *Styron 475*.

The sheeting dies, which have five-zone control of heat, are adjustable between 0.020 and 0.140 in. and can produce sheets 48 in. wide. The sheet is drawn off the die and passed round three highly-polished chromium-plated rolls, the temperatures of which can be maintained very closely.

Dust Collector

The name of the dust collector which was described on page 289 of our August issue was misspelt; the correct name is *Cyclo*.



Inside the synthesis building at São Paulo

WHAT'S NEWS about

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in the top postcard attached, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

Elevator

An elevator that can raise powdered or granular materials to a height of 5 ft. or so in quantities up to $4\frac{1}{2}$ tons/hr. has an elevating assembly that is fed from a hopper incorporated in the unit. This hopper, while having a capacity of over $4\frac{1}{2}$ cu. ft., has a feeding height of only 15 in. from ground level.

The actual elevating elements take the form of a V rope-type rubber canvas endless belt, into which stainless-steel spindles are bonded. These spindles carry the flights, which can be supplied in either polythene or rubber. Using these flights, the elevator works on the mass-flow principle. Furthermore, using the same type of stainless steel bonded to rubber V belt, a very neat bucket attachment can be applied in cases where the particular form of material is not amenable to mass elevation or where an exceedingly accurate rate of feed is called for.

The cross-section area of the elevator tunnel is $4\frac{1}{2} \times 4\frac{1}{2}$ in. and, implemented by an infinitely variable speed gear, elevator belt speeds of 5 to 32 ft./min. are obtainable.

Using the bucket gear, accurately gauged outputs up to 10 cwt./hr. are obtained, while up to $4\frac{1}{2}$ tons/hr. can be attained with mass flow.

The unit is powered by a $\frac{1}{4}$ -h.p. electric motor, which is fitted with reversing gear. This latter is called into operation when it is desired to clean out the machine, the motor being switched into reverse, whereupon the content of the elevator and hopper is completely evacuated through a small trapdoor located in the base of the unit.

The construction of the elevator belt is claimed to be unique in that it contains no cavities or articulated parts

which can harbour dirt or be contaminated by attrition. The side panels of the chassis are fitted with quick-release clips. When the unit requires cleaning, these panels can be detached and the elevator belt and its pulleys removed all in a matter of 3 or 4 min. Moreover, this dismantling can be carried out entirely without the use of tools.

CPE 334

★ Plant

★ Equipment

★ Materials

★ Processes

movement is required to make and break the control relay.

The *Transitrol* pyrometric controller is stated to be suitable also for the control of pressure, vacuum, torque, fluid flow, liquid level, viscosity, smoke and light detection, etc.—in fact, any process signal that can be converted to an electric current or voltage.

CPE 335

Temperature controller

The *Transitrol* automatic temperature-controller operates on a new principle which utilises a transistor, doing away with the need for thermionic valves, magnetic amplifiers and oscillator circuits.

The control arm, which is adjustable externally to the required temperature set point, is fitted with a photo-sensitive transistor, optical lens and low-level light source. A flag is connected to the pointer arm of the galvanometer, which passes freely between light source and transistor. When the desired control point is reached, the light source is cut off from the transistor, thus de-energising the control relay and shutting off the heating medium.

The design of the optical system ensures that only a minute pointer



'Transitrol' temperature controller.

Plastic coating for metal

A tough, rubbery plastic when applied to metal articles is claimed to give complete protection against corrosion and abrasion. By dipping the article in *Crocell*, a thick, flexible skin is formed, completely enveloping the article. It is transparent and identifying marks or numbers can be read through it with ease.

Perhaps the greatest advantage of this skin is its easy removal. An incision in the skin by a sharp object will allow the coating to be peeled off instantly, and the protected article is left ready for use, gleaming with a slight film of purest lubricating oil.

When this product was originally developed, it was assumed that its use would be restricted to relatively small and expensive objects such as precision tools and gauges, measuring instruments, etc. However, objects as large as 4 ft. in length are regularly being protected by it.

As the skin can only be applied by dipping articles into the molten plastic, special dipping pots or tanks are necessary. A full range of these is available from the manufacturers.

Continuous over-heating may degrade and darken the colour of the material; 160 to 185°C. is the optimum temperature range, but in any case

C.P.E.'S MONTHLY REPORT AND READER SERVICE

temperatures above 200°C. are not recommended. The thickness of the coating can be varied within this temperature range. Thinner coatings can be applied by first heating the parts to a temperature in the same region as the molten plastic, 1 lb. of which will coat approximately 3.45 sq. ft. at a film thickness of 0.06 in. The specific gravity of Crocell is approximately 0.910. Its 'drop' point when warmed slowly is 140 to 145°C. The makers claim that it will maintain its original colour almost completely, even if heated continuously for 150 hr. at 180°C.

CPE 336

Creep test loading device

A creep-test loading device for testing adhesively bonded lap joints is illustrated in the accompanying photograph. Two strips of aluminium have been bonded together with Redux adhesive, with an overlap of $\frac{1}{2}$ in. The strips are 1-in. wide, so that the bonded area of the joint is $\frac{1}{2}$ sq. in. One end of the joined strips is anchored at the bottom of the machine, and the other end is anchored to the central tie rod which is pushed upwards by the spring. In this case the spring has been compressed to give a load of 500 lb. so that the tie rod exerts a pull on the joined strip of 500 lb., giving rise to a shear load of 1,000 p.s.i. on the $\frac{1}{2}$ -sq.in. bonded area of the joint.

The temperature at the joint is raised by heating the bonded strips. Electrical resistance heating elements are clamped either side of the aluminium strip, both above and below the bonded overlap. By regulating the voltage with the Variac transformer, above the Servograph recorder, the current supply to the resistance heating elements can be controlled. In this case sufficient current is being supplied to maintain the joint temperature at 100°C. Heat is lost from the strips by conduction, and by convection, and the current to the heaters must be just sufficient to balance these heat losses.

The temperature at the bonded overlap is measured and recorded by means of thermocouples clipped to the jointed strip at the $\frac{1}{2}$ -in. overlap. A voltage of the order of 5 mv./100°C. is generated at the hot junction of the iron-constantan thermocouple which is clipped to the joint. This voltage deflects the sensitive millivoltmeter in the recorder, and the deflection of the meter is sensed by the

V-BELTS

The Dixlink V-belt has been designed for use where an endless unit is not suitable owing either to structural restrictions or to fixed centres. It is manufactured in various sizes and is normally supplied in coils of 50 ft. It is also available in oil-, heat- and fire-resisting qualities.

A belt of any length can be detached in seconds from a stock coil and can be installed and running in a matter of minutes. The makers point out that, being detachable, the Dixlink eliminates dismantling costs where pulleys are mounted between bearings or in confined positions. They also point out that the belts can be fitted to any length without the necessity to design a standard centre distance.

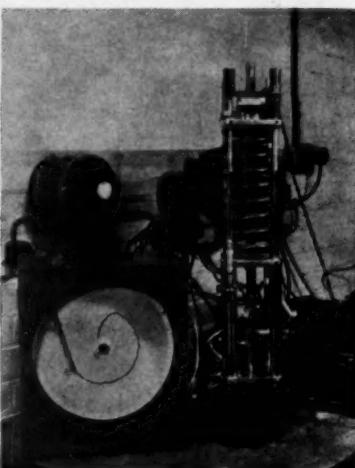
It is stated that the construction of these belts allows free air circulation to dissipate the heat caused by internal friction during flexing.

The makers lay down recommendations concerning the most suitable belt according to horse power and faster-shaft speed.

CPE 338

capacitance proximity method which, by means of a capacitance bridge and amplifier, controls the servo power which moves the recording pen and plots a trace on the circular recording chart revolving once in 24 hr. Any variation in the temperature of the loaded joint is shown on the temperature trace on the recorder chart.

CPE 337



'Servograph' Mark II loading device.

Flameproof energy regulator

The introduction of an energy regulator housed in a flameproof case makes possible the use of electric heating mantles, jackets, panels, tapes, etc., in flameproof areas. The new regulator has a maximum loading of 1.5 kw. and operates on the proportional time principle. The standard casing measures $11\frac{1}{2} \times 6\frac{1}{2} \times 4\frac{1}{2}$ in. and has two $\frac{3}{4}$ -in. conduit entries. Four fixing lugs are provided. The control knob turns over a dial with integrally-cast calibrations, so that any desired setting within the range can be selected.

If required, a casing with a neon indicator lamp can also be supplied. The energy regulator is designed to control a single circuit. Similar units comprising regulators for two or more circuits are available to control larger installations or single heaters with several circuits arranged to achieve the required temperature gradient.

CPE 339

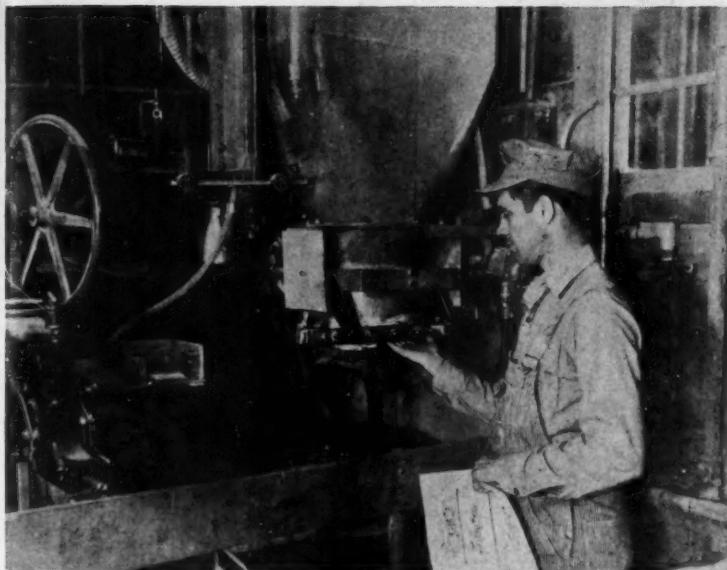
Polarographs

For routine analysis in metallurgy, plastics, medicine, petroleum, food and other spheres, polarographs are available which enable the necessary results to be obtained using only very small quantities of material and which enable analysis to be repeated a number of times on the same specimen solution.

A potentiometric polarograph now available is claimed to give high-speed permanent records, and the damping may be varied at will by operating a selector switch. Either direct or derivative polarograms may be taken. The instrument incorporates a Tinsley vibration-proof d.c. amplifier which provides distortionless and linear amplification. Multiple ranges are available covering 0.1 to 150 microamperes in 34 steps. A special feature of the latest model, the Mark 15, is the ease of access which has been provided to all components.

The Mark 15 recording polarograph is particularly suitable where the instrument is in fairly constant use, but in many cases the volume and scope of the analytical work do not warrant the outlay for such an instrument. A less expensive instrument has been introduced which, although non-recording, retains many features of the larger model, including the derivative circuit. This is made possible by the use of a motor-driven potentiometer.

CPE 340



Operator demonstrating efficacy of bag holder safety device.

Bagging unit with built-in safety

Accident-proof operation of an air-operated universal bag holder is demonstrated in the accompanying photo, taken at Donovan's Feed Mill, Albert Lea, Minn., U.S. The operator has placed his hand between the bag holder and bagging spout of an automatic bagging scale to demonstrate an important safety feature.

The pneumatic mechanism that closes the bag clamps around the spout is designed to apply high pressure only during the last $\frac{1}{16}$ in. of the clamps' travel. In this way all danger of an operator's hand being hurt in the mechanism is eliminated.

Operation of the bag holder is controlled by a foot valve and an air control unit. The foot valve controls the opening and closing of the bag holder, leaving the operator's hands free to attach and remove bags, thus increasing filling speeds and bagging rates.

The system operates on air pressure from 30 to 40 p.s.i. and requires 2 cu.ft./min. of free air compressed to 60 p.s.i. for 10 cycles/min. Standard bag holders are equipped with round or oval spouts in various sizes to suit the bags to be filled. A small-diameter slip-on spout is available for manual filling of small bags, with the spout held in place by the universal bag holder. In this case, bags are manually held in place as they are filled.

The universal bag holder will hold burlap, cotton, paper or lined bags and is especially suitable for multi-wall

paper bags with gussets, which it holds in place without damaging the gussets. Extensions on the bag clamps form 'gusset grips,' which hold the gussets as the bag is being filled. These grips are rubber lined for better seal and grip, and are adjustable to compensate for gradual wear.

The universal bag holder can be combined with automatic scale and packer operation, so that opening and closing of the clamping device can be synchronised with weighing and packing.

The universal bag holder is also available in a manually operated model.

CPE 341

Flow measurement

An American company has designed a flowmeter for purge service or for indication of flow rate at elevated pressures. The meter has been designed for handling hazardous fluids over a wide range of temperature and pressure generally encountered. The flow rate is measured by the movement of a tapered plug in a fixed orifice.

Flow indication is by a tubular follower operating outside the fluid stream and coupled magnetically to an extension on the tapered plug. The model is built for operation up to 1,500 p.s.i. (gauge) and 400°F. Five standard plug and orifice sets are available to cover flows from 1.5 to 180 gal./hr. of water in a single body size.

CPE 342

Protective tape for structural steelwork

The makers of a protective tape for structural steelwork claim that it immediately makes a complete air- and water-proof seal, thus providing protection against all corrosive influences, that it is unalterable in composition and plasticity over a wide range of temperatures, is highly resistant to acids, alkalis and salts, will neither crack nor harden, and is unaffected by vibration. Once applied, no further attention is necessary unless it is desirable to avoid the accumulation of fluff or dust, or to alter the appearance, when it can be painted, preferably first applying a coat of knotting varnish.

The plasticity of the tape ensures that it can be formed faithfully around all surface irregularities of the underlying metal and to all awkward shapes and contours, such as joints, couplings, bolt and rivet heads, angle cleats, etc.

In most cases, where conditions are not particularly severe, the tape will prevent condensation; in other cases it will reduce the formation of condensate, and such condensation as does occur will be free from iron oxide staining properties, it is stated.

CPE 343

Water testers

Two types of water tester now available are a portable instrument for examining samples and a water purity meter for continuous tests. With the portable model, routine tests can be carried out by unskilled operators, while the purity meter enables the condition of water in a system to be kept under constant observation.

The portable *Dionic* water tester comprises two units—the conductivity tube and the conductivity meter. The conductivity tube is fitted to the lid of the wooden carrying case and consists of a glass container into which is poured a sample of the water to be tested. The cover of the container supports an inner graduated tube, two electrodes and a transmitter. Temperature compensation is provided for.

The conductivity meter contains a direct-reading instrument and a small hand-driven generator for providing the necessary current. Two patterns are available, a lightweight meter in an aluminium case and the longer-scale meter in wooden case.

CPE 344

Water de-ioniser for laboratory use

A water de-ioniser that is now available for laboratory use comprises an all-glass apparatus which, by the use of a metal stand, can be attached to a wall, or fixed to a bench, where it occupies less than 1 sq. ft. of space.

The de-ionising column consists of a 12-in. length of 3-in.-diam. Pyrex pipeline, connected to the upper end of which, by means of a plastics union, is a 5-l. spherical flask approximately 8½ in. diam. The neck of the flask is formed with a B34 socket, into which a constant-level overflow arrangement is fitted. The lower end of the column is connected to a 3-in. length of pipeline reduced to terminate in a B24 socket. This joint is connected to an outlet tap either directly or through the conductivity cell, B51-255/8. The resin, when placed in the 12-in. column, is supported on a close-fitting sintered glass disc, porosity grade 1, 65 mm. diam., mounted between two polythene washers.

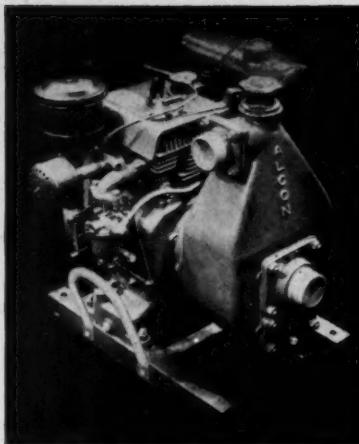
Rubber or polythene connecting tubing for the water supply to overflow from the de-ioniser can be neatly carried up inside the supporting tube.

The quality of the effluent water and the need for regeneration of the column can be monitored by normal pH methods, by the use of silver nitrate, or by direct measurement of the conductivity of the water. A conductivity cell and indicating unit is available as an optional extra. The cell consists of two-plane parallel platinum electrodes 1 cm. square and 0.5 cm. apart, having therefore a cell constant of approximately 0.5. An indicating unit is available to give a continuous indication of the conductivity of the water. **CPE 345**

Transducer for chemical production

A high-power magnetostriction-type transducer designed specifically for large-scale chemical production was demonstrated in the United States recently. This 400-w., 25-kc. transducer can be grouped externally on existing process equipment and driven in tandem by electronic or rotary-driven, above-audible frequency generators ranging in power from 2,000 to 150,000 w. It can be used with liquids at temperatures far above boiling point, according to the manufacturers.

CPE 346



Two men can carry this centrifugal, self-priming pump, using the two handles.

Self-priming pump

The redesigned *Alcon* 2-in. pump has an output of 10,000 gal./hr. and a head of 100 ft. Carrying handles make this pump, which weighs 98 lb., easily portable by two people. It is available with a JAP or Villiers engine, or with a totally enclosed electric motor. It can also be supplied on trolley mounted.

Variable output is achieved through engine-speed control. Petrol, kerosene, diesel and lubricating oils can be handled effectively with this unit. Liquid manure and other liquids containing up to 25% solids can also be handled effectively.

The unit consists of a centrifugal self-priming pump, spigot mounted directly on to the engine crankcase, with the impeller fitted to the extension to the engine crankshaft. The engine and the pump combined are mounted on a baseplate.

The priming is by water recirculation. Efficient priming is obtained by the use of adequate recirculation passages, ample priming water and a large chamber for the separation of air and water. There are no priming valves or moving parts contained in the priming system and it is, therefore, claimed that there is no possibility of the self-priming characteristic failing. After the pump has been primed the output can be varied by means of the engine-speed control. A simple non-return valve of hard-wearing rubber is fitted to the inlet.

The impeller is of the three-bladed open type, manufactured from close-grained cast iron. The seal incorporated in the pump is a mechanical face type, utilising for standard con-

ditions a centrifugally cast-iron counter-face with a carbon running face and *Hycar* rubber sealing bellows.

A hand-operated lever is fitted on the side of the engine cowl, by which ready adjustment may be made to the speed of the engine, thus controlling the output from the pump.

Cast-iron units are also available, and the pump can be supplied with a shaft extension and pulley suitable for belt drive.

CPE 347

Fork-lift truck and squeeze clamp

A new truck has recently been added to a range of fork-lift trucks manufactured by a British firm. The truck, known as the *Straddle Stack*, will stack in very restricted spaces up to a height of 12 ft., the minimum aisle width required being 5 ft. 6 in. when stacking at 90°.

The price of £520 is inclusive of batteries and built-in charger. A Westinghouse wall-mounted charger is available for a nominal charge of £10 above the basic price.

The attachments available include fork extensions, crane, ram, barrel-lifting forks, and a squeeze clamp. This last is available for lifting and stacking paper reels, bales of wood or paper, boxes, drums, barrels, etc. The clamp can be fitted to the truck in 1½ min. and is power operated with a simple lever.

CPE 348

Foam lubrication

A penetrating oil and spring lubricant, and an easing fluid and rust remover, are available in 12-oz. aerosol packs under the name of *Aerozene* and *Rusolvent*, respectively. It is stated that, in the case of the former, an entirely new conception in lubrication — foam lubrication — has been achieved. The lubricant is ejected in a powerful, accurate jet (a 4-in. circle at 7 ft.) and produces on the part to be lubricated a highly penetrating graphite foam which, it is claimed, has remarkable 'wetting out' or 'creep' properties. When sprayed on heavily encrusted spring shackle bolts it was found to have reached the inner surface within a few minutes, and was persistent. It has special additives that act as an efficient carrier for the colloidal graphite which ensures persistent lubrication after application.

Both packs are non-inflammable and retail at 7s. 6d. each. **CPE 349**

Analysis of gases and liquids at high temperatures

A vapour fractometer (gas chromatography device) which permits fast analysis of gases and liquids boiling up to 300°C. at operating temperatures up to 225°C., has been announced by an American company. A precision liquid sampling system has also been developed as an accessory for the instrument.

It is stated that the instrument's high operating temperatures will permit the analysis of such compounds as esters, cresols, phenols, xylools, chlorinated aromatics and the higher alcohols. The instrument's temperature control allows for any desired temperature from room level up to 225°C.

The new instrument also incorporates a sample fraction-collecting three-way solenoid valve operated by a switch on the control panel so that individual fractions can be collected and separated as they emerge from the instrument, if desired. The collecting system enables re-use, separation and additional component analysis (by spectroscopic and other methods) of the sample. The valve is located near the exit port of the detector to reduce the possibility of loss of separation.

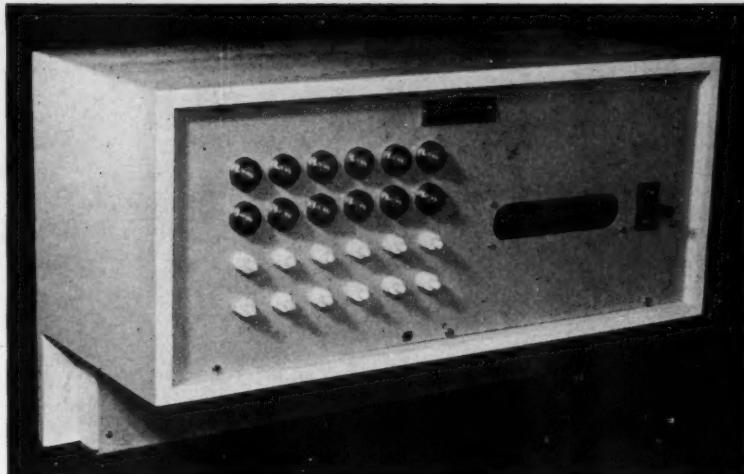
CPE 350

McLeod gauge for heavy testing

A new McLeod gauge has been designed as a result of the experience obtained in employing McLeod gauges for the routine testing of vacuum pumps, when it was often found that the conventional laboratory-type glass gauges were inadequately protected and far too fragile for the daily requirements of continuous heavy testing. Whilst it was impossible to avoid the comparatively fragile gauge head, the design which has been newly developed employs a shrouded case for the glass part and robust metal tubes for the barometric leg and mercury container. The gauge head is joined to the metal tubes by means of conventional O-ring-sealed vacuum unions and can quickly be replaced in the event of breakage.

An important feature is the method of operation, which is by means of displacement with a wooden plunger. This is claimed to give a fine control with easy operation.

CPE 351



Fire warning unit.

Fire detection

The *Auto-Thermic* fire detection equipment operates on a constant-current monitoring principle. A current circulates through the automatic detectors, manual fire pushes and connecting cables, and if for any reason this current is interrupted the alarms will be operated. If the current is interrupted due to the operation of a detector, manual fire push or by a break or short circuit in the cables, the relay coil will lose its holding current and consequently release its contacts, operating the alarms.

The alarm system is connected by a pair of private Post Office lines to the local fire brigade. A feature of the design of this system is the facility with which the officer on duty at the fire station is enabled to make a

routine test of the system once a day — by operating a switch on the control panel installed by the company in the fire station, which in turn sends a signal to the central alarm cabinet within the building, a series of automatic tests then taking place on the equipment.

The automatic detectors consist of either fusible link or of a compensated bimetal type. The fusible link unit has two phosphor-bronze springs held in tension and joined together with a fusible alloy which melts at 120°F. At this temperature the springs fly apart and interrupt the circuit.

The compensated bimetal unit is more sensitive than the fusible link. If the temperature rises at the rate of 20°F./min., the bimetal unit operates the alarms within 90 sec.

CPE 352

Dry-chemical fire extinguisher

A new, pressure-operated, dry-chemical fire extinguisher which weighs less than 10 lb. when fully charged is now being marketed. It has been designed to meet the need for a small, yet powerful, fire-smothering unit to deal with outbreaks involving petrol, oils, paints, spirits, solvents, greases, etc., and can also be used with safety on fires involving electrical equipment.

Charged with 5 lb. of dry chemical powder, the extinguisher is pressurised with nitrogen up to 150 p.s.i., although it will still operate satisfactorily at pressures as low as 100 lb. The pressure is constantly recorded on a gauge

embodied in the head of the operating valve, a feature which provides the operator with an instant check on the condition of the extinguisher.

The model is available with either a pistol-grip or squeeze-grip operating head, each of which requires only normal hand pressure to actuate the extinguisher after the safety pin has been removed. Both types provide speedy, accurate control over the discharge of dry chemical which can be turned on or off at will. A specially designed nozzle projects the contents in the form of a fan-shaped jet with an angle of over 30°, smothering the fire in a thick blanket of dry chemical

powder. The extinguisher has a range of about 8 ft.

The design of the extinguisher enables it to be recharged after use simply by topping up or refilling the cylinder with 5 lb. of dry chemical. If nitrogen is not available, the extinguisher can be pressurised from a garage or factory airline or from an efficient motor-car foot pump with dry air.

Portable dry-chemical extinguishers are also available with a capacity of 25 lb. of dry chemical, while there is a trolley unit available having a capacity of 150 lb.

CPE 353

Resins for coatings

Epoxy resins marketed under the name Araldite are claimed to possess remarkable adhesion to metals and to combine an unusual degree of flexibility with toughness and resistance to chemical attack. They have numerous applications as surface coatings.

One product is a two-part formulation, consisting of a resin and a hardener, which has been specially developed to form the base of cold-curing finishes or, alternatively, of finishes that cure rapidly at elevated temperatures. Coatings based on this formulation are recommended when rapid drying coatings, possessing good resistance to water and chemicals, etc., are required. These coatings may be clear or pigmented, as desired, and it is claimed that, besides curing without blushing, even at high relative humidity, they are also free from such surface defects as cissing and pinholing and do not become brittle on ageing. They are also said to offer excellent adhesion to metals, wood, ceramics, plastics, plaster and brick-work, etc.

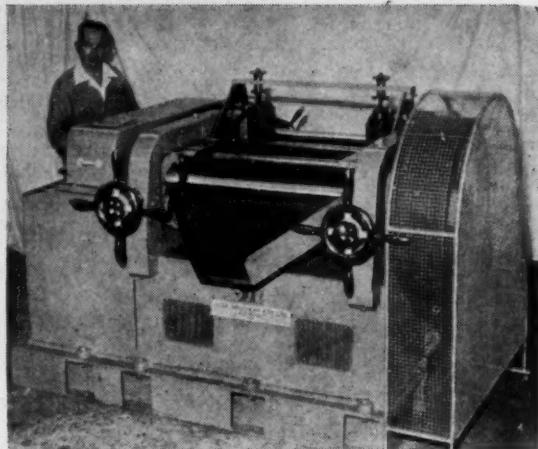
CPE 354



CHARGE DETECTOR

The Statigun static charge detector measures potential gradients in air over the range 0 to 300 kv./ft. It is used in the textile, plastics, rubber, paper and explosives industries.

CPE 355



ROLLER MILLS

This picture shows one of a new series of Australian high-speed rollers which are stated to produce high rates of throughput and are convertible to the floating-roll principle. This method of roll adjustment, when used with readily ground material, is claimed by the manufacturers to give an increased production of up to 15%. The mill is available in a range from $3 \times 6\frac{1}{2}$ in. to 16×40 in.

CPE 356

Ultrasonic thickness gauges

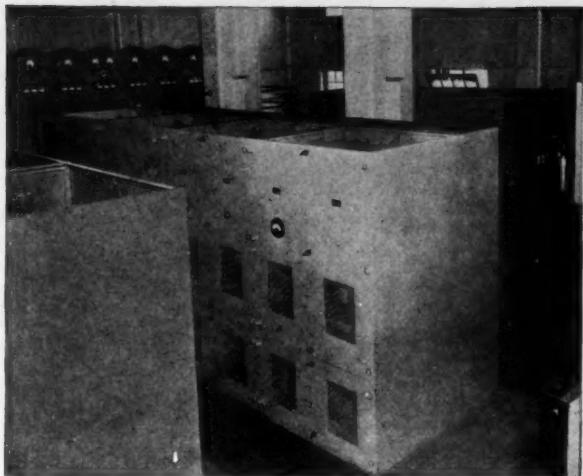
The chemical and oil industries, faced with problems of thickness measurements on pressure vessels, pipes and other plant, have found ultrasonic gauging an alternative to drilling or dismantling. Recent advances in electronics have made it possible to produce a battery-operated, self-contained and portable gauge which is sufficiently simple and robust for constant use on open sites by ordinary maintenance personnel. The instrument operates on the resonance principle. A variable oscillator within the instrument generates an ultrasonic signal, which is injected through a crystal probe into the plate whose thickness is to be measured. Just as light is reflected by a mirror, so the signal is reflected by the far, inaccessible side of the plate and is picked up again by the probe. If the outgoing and reflected signals are in phase, they will reinforce each other and resonance occurs. This condition is easily recognised by a sudden rise of the hum in the earphones, and by a sharp deflection of the needle of the meter mounted on the instrument.

Resonance can only occur if the wall thickness is a direct multiple of the wavelength of the signal. In operation, the probe is applied to the plate and the wavelength is slowly changed by means of the control knob, until resonance is achieved. The

adjustment for resonance is extremely sharp. The thickness of the plate is read off a scale graduated directly in inches, and is found opposite another scale showing the fundamental resonant frequency. The gauge is suitable for thickness measurements from 0.06 to 12 in. in steel, and for a similar range in most other metals.

The latest model of this gauge, which is provided with a 50-ft. lead between the instrument and the probe, has a long lead which enables one operator to apply the probe in high or awkward locations, while another operator, at a central position, takes the readings on the gauge. It is thus often possible to dispense with the need for staging and to use ladders instead, with a consequent saving in time and cost.

As far as the chemical manufacturing industry is concerned, the main advantage of the gauge lies in the fact that corrosion surveys can be carried out without interfering with the manufacturing process. It is stated that completely satisfactory readings have been taken on pressure vessels containing hot acid, on Horton spheres and cracking towers. The high cost of shut-downs occasioned by the consequent loss of production has thus been eliminated, and more frequent checks have made a closer control over plant conditions possible. CPE 357



These three 870 kw., pumpless, steel-tank rectifier equipments supply the I.C.I. electrolytic plant at Yarraville, Melbourne, Australia.

Rectifiers for production of NaOH and KCl

Three 870-kw. steel-tank rectifier equipments have been supplied to the I.C.I. plant for the electrolytic production of caustic soda and potassium chloride at Yarraville, Melbourne, Australia. Each comprises four cylinders and has an output of 3,480 amp. at 200 to 250 v. The cylinders, which are housed in sheet-steel cubicles, are of pumpless, air-cooled design and are fitted with six side-arm anodes and three auxiliary anodes. The cylinder itself occupies the upper portion of the cubicle, while its cooling fan and other auxiliaries are mounted immediately beneath it. The design of the equipments is such that, following continuous operation at a maximum ambient temperature of 45°C., they are capable of sustaining, without undue heating, an overload of 10% of the full load current for 2 hr., or a momentary overload of 30%.

Each four-cylinder rectifier bank is supplied from the 6.6-kv., three-phase, 50-cycle mains through an outdoor transformer, in the design of which particular attention was paid to the bracing of the windings, in order to ensure reliable service in this arduous duty. The windings are connected in delta/double-star, to give the necessary six-phase output, the interphase transformer being mounted in the main transformer tank. The L.V. connections pass through the wall of the substation and terminate on six busbars which run behind the rectifier cubicles. The anodes of the four

cylinders are connected to these busbars through series anode chokes which are incorporated to ensure correct load sharing between the cylinders. The rectifier auxiliaries are supplied from a tertiary winding on the main transformer.

The 6.6-kv. primary winding of the transformer is provided with link tapings for $+2\frac{1}{2}\%$ and $+5\%$, and also with an on-load tapping switch by means of which the output voltage from the rectifier can be varied over the range 200 to 250 v. d.c. in 20 steps.

The output from each rectifier equipment is fed to the d.c. busbars through a 4,000-amp, single-pole, air-break circuit breaker of the line-contact type. This breaker, which is mounted on the output control panel, is arranged for manual operation and is fitted with overload and no-voltage trip coils, together with a polarised reverse-current protective device. CPE 358

Thickness gauge for coatings

An instrument known as the *Elcometer* will measure the thickness of non-magnetic coatings on a ferrous base. It operates by means of a strong and durable magnet, so that the magnetic flux across an air gap in the instrument will vary according to the proximity of a ferrous surface to two contact spheres at the base of the meter. CPE 359

Intercommunication

A battery-equipped loudspeaking two-way 'intercom,' called *Kedafon* is thought to be the smallest of its kind in the world. It requires no installation and it costs £15 10s. 6d.

This unit, the manufacturers say, ignores distance, is completely portable, and may be used inside a building or in the open, or to connect the outside with inside. Both units may be moved from place to place wherever they will best link two persons who need to be in instant direct contact. The flex which connects the two speaking units can be of any desired length.

An unusual feature of the *Kedafon* is that of contact without signal from the master unit. Merely by touching a button the operator on the master unit is instantly in listening and speaking contact with the person or persons on the sub-unit end. The sub-unit operator must signal before he can make contact with the master unit.

Maintenance is stated to be very little. The batteries need to be replaced every six months or so according to the frequency with which set is used. CPE 360

Inductive flowmeter

An instrument known as the *Altoflux* inductive flowmeter is claimed to have a number of advantages for measuring the flow velocities and flow quantities of liquids, slurries, etc. It is stated that the possibilities for the use of the instrument are practically unlimited if only the liquids or slurries to be measured conform to the minimal requirements of electrical conductivity.

The detector can be mounted in any position, is insensitive to pressure and can easily be moved. It does not require more maintenance and supervision than the connecting pipeline and, by application of the remote-indicating principle, it can be mounted in locations of difficult access. It is stated that flow measurement is not influenced by the presence of solid matter in the liquid or by variations of flow profile, viscosity, concentration, specific gravity, pressure or temperature.

Fibres or coarse fragments in the liquid pass the detector without obstructing it. Crystal slurries, mixtures of sand and water, mud, fibre slurries, etc., can be measured with the *Altoflux* without difficulty, it is stated. The flow profile being of no

influence the detector can be mounted immediately behind bends and valves. For the same reason viscous liquids and pastes can be measured.

The constructional principle of the *Altoflux* detector allows the application of modern lining materials. Hence very aggressive liquids and mixtures involving great wear can also be handled.

The manufacturers of the *Altoflux* state that the combination of the results obtained by measuring with this instrument together with another electrically measured function creates entirely new possibilities for production checking, e.g. in combination with electrical measurement of temperature the heat transfer of a liquid is obtained and in combination with electrical measurement of concentration the quantity of transported solid matter can be determined. For the latter measurement a special device, the *Altocon*, has been conceived.

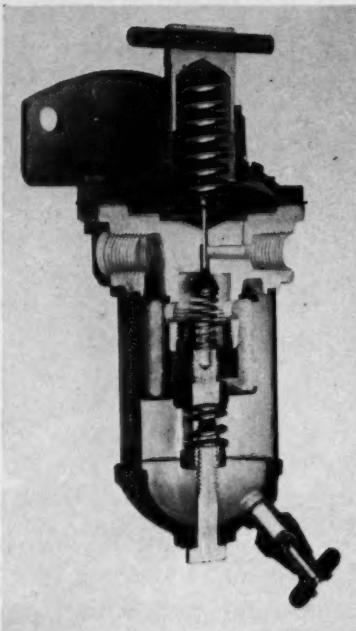
This *Altocon* concentration meter is based on the principle that, if an electrically conductive liquid contains solid particles having a specific conductivity different to that of the liquid itself, the difference of conductivity between the mixture and the original liquid has a definite relation to the concentration of solid particles.

CPE 361

Nucleonic thickness gauges

The principle on which the *Atomat* nucleonic thickness gauge works is that, when nuclear radiation strikes a sheet of paper, metal or other material, part of the radiation is reflected or scattered and part is absorbed, whilst the remainder passes through the sheet. The *Atomat* employs either the radiation which penetrates (transmission gauge) or that which is scattered (backscatter gauge) as the basis of measurement.

In the case of the transmission *Atomat*, the radiation which penetrates the sheet falls on to a detector, stimulating an electrical current which after amplification is fed to an indicator. The current and therefore the indicator reading are dependent on the amount of radiation penetrating the sheet, which in turn is governed by the weight per unit area. The indicator is normally calibrated in weight per unit area, but when the density is constant as in the case of metals it may be calibrated in thickness. If it is necessary to measure a coating on a sheet rather than its total weight, the



AIR FILTER REGULATOR SET

The air set illustrated here combines the features of dripwell, 50-micron ceramic cartridge-type filter, tight shut-off reducing valve and relief valve, all in one unit. According to the makers, this instrument provides an extremely stable air output in spite of wide fluctuations of supply or demand, or against dead-end service.

The filter element can quickly and easily be replaced by undoing only one bolt and one nut. Light alloy and steel have been completely eliminated from the all-brass body, which is rated at 250 p.s.i.

CPE 363

differential *Atomat* is employed. This is fitted with two measuring heads, one measuring the uncoated sheet, the other the coated sheet, the difference between the two (i.e. the weight of coating) being indicated by the instrument. By this method, variations in the weight of the uncoated sheet are taken into consideration and the true coating weight is indicated.

When the material to be gauged is accessible from one side only, the backscatter *Atomat* is used. In this case the reflected or scattered radiation is utilised by a special measuring head having a radioactive source and detector mounted in one unit. The radiation passes from the source, through the material, strikes the backing (e.g. a calender bowl) and is reflected on to the detector.

A COOLANT FOR TRANSFORMERS AT HIGH TEMPERATURES

An interim report has been issued on the use of *Aroclor* 1248 as a coolant for transformers designed to operate at high temperatures. In any transformer the internal loss of energy is due, firstly, to resistance heating of the coils and, secondly, to eddy-current heating of the core. These losses are approximately directly proportional to the kva. transmitted by the transformer, and therefore the internal temperature of a transformer on load is proportional to the load. It is this that limits the load, but if cooling were made more efficient, or if a higher temperature could be tolerated, loading might then be increased.

The first method may be achieved by the use of forced circulation, and the second by means of air-cooled units having class H insulation. The highest temperature possible with oil-cooled unit is 120°C. Above this temperature oil is insufficiently stable. The new coolant is claimed to be stable at temperatures considerably higher than this, and the manufacturers are now carrying out tests to determine what limits can be tolerated. It is certainly possible to operate at maximum coil temperatures of 160°C., and it is expected that a maximum temperature of 200°C. could be tolerated.

The report describes work that has been carried out on breakdown strength and other properties; temperature/load relations; insulation; temperature rise on switching on; and the use of a scavenger to remove hydrogen chloride which will be dissolved in the fluid in the event of arcing. In future work, it is intended trying the effect of using an aluminium winding instead of a copper one.

CPE 364

In practice it is only necessary for the operator to set the appropriate dial to the weight at which the product should be running. The weight indicator will then show the actual weight of the product in the measuring gap, whilst the deviation indicator will show by how much the actual weight differs from the set weight.

CPE 362

World News

CANADA

New Ontario newsprint mill

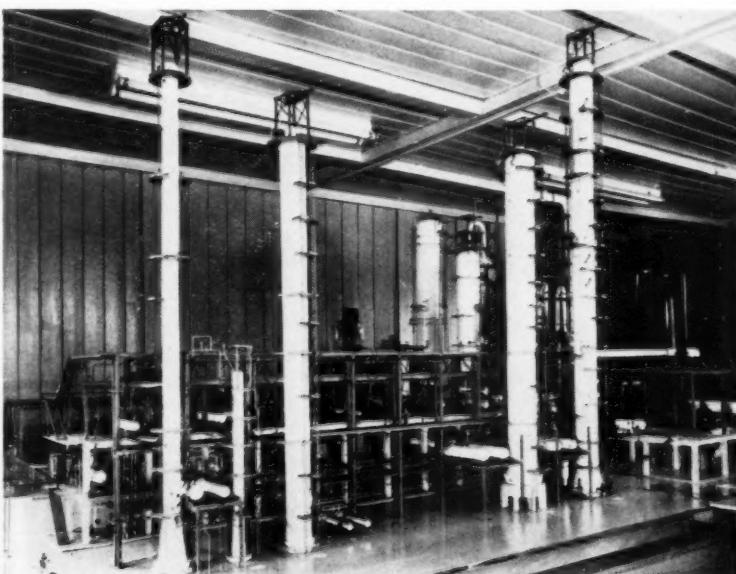
The Anglo-Newfoundland Development Co. Ltd. will build a \$60-million newsprint mill in north-western Ontario which will utilise a minimum of 150,000 cords of pulpwood annually (13 cords make 1 ton of newsprint). The mill will be located near Sioux Lookout, 175 miles northwest of Fort William.

Anglo-Newfoundland Development produced 232,000 tons of newsprint last year from its mill in Grand Falls, Newfoundland, which has a daily capacity of some 745 tons.

Nylon resin manufacture

Dupont of Canada Ltd. has announced that it will undertake the manufacture of Zytel nylon resin. Installation of the required equipment will begin immediately at the company's Kingston, Ontario, nylon yarn plant, with initial production expected early in 1957. Previously the resin was imported from the U.S.

The company said the plant would have adequate capacity to meet all Canadian requirements in the foreseeable future. Zytel is a moulding powder which is used in the manufacture of mechanical parts such as gears and bearings.



Model of the gas-treating plant III (scale 1:50) at the Shell installations at Pernis (see comment on earlier page).

SINGAPORE

Steel mill

Malaya's first heavy industry, a 1-million Malayan dollar steel mill, is beginning production at Singapore and will make steel for local building.

It will use scrap steel from Singapore and the Federation of Malaya which is now mainly exported to Hong Kong and Japan. The owners say the new mill will have an output of 4,000 tons of steel bars during the first year, 7,000 tons during the second and 10,000 tons during the third.

The operating company for the mill, which is at Bukit Timah, is the Singapore Steel & Iron Mills Ltd. The managing director, Mr. Pang Nin Chen, formerly had steel interests in Hong Kong.

CZECHOSLOVAKIA

Cellulose project

A plant for the production of cellulose from river reeds is to be built jointly at Braila on the Danube by Rumania, Poland, East Germany and Czechoslovakia. The plant, which will have an annual output of 200,000 tons, is to be completed by the end of 1960.

Czechoslovakia will contribute blueprints for part of the project and supply some of the equipment.

SWEDEN

Increased production of petrochemicals

Resulting from an ever-growing demand for petrochemicals, Sweden is considerably increasing her domestic production of such products. According to the Stockholm newspaper, *Svenska Dagbladet*, it is estimated that the production of solvents, plastics, synthetic rubber, artificial fertilisers, etc., will total 200,000 tons/year. Thanks to the extension of the capacity of the Swedish petroleum refineries in recent years from 400,000 tons in 1952 to 7½ million tons in 1955, there is an ample supply of raw materials.

JAPAN

Glass-fibre plant approved

The Japanese Government has approved the joint establishment of a glass-fibre plant in Japan by two Japanese companies and an American firm, according to the Ministry of Trade in Tokyo. The decision followed the Fair Trade Commission's statement that the projected plant was not likely to monopolise glass-fibre production in Japan.

The two Japanese companies, the Asahi Glass and Nitto Spinning companies, will establish the new company with the Owens Corning Fibre Corporation of America. Capital will be 1,100 million yen.

The company will produce glass fibre, continuous filament and glass wool to supply 60% of Japan's domestic requirements, which amount to 500 or 600 tons p.a.

FRANCE

Search for more coal in Loire basin

Twenty-six soundings are to be made in the Loire basin for new supplies of coal. So far, only the outer edges of the field have been worked.

The basin covers some 50,000 acres, divided by many faults. Working began on the outcrops, and for years past the coal has come from near the surface. The centre of the basin has not yet been explored, but it is expected that the 26 soundings will give highly satisfactory results.

PORTUGAL

Cement project

A new factory for cement production in Angola will start running within six or seven months, in the area of 'Cacuaco,' near Lobito. With this new factory it is hoped that the present shortage of cement in Angola will disappear, and that the quality of cement will be improved.

PHILIPPINES

Acid and fertiliser plant

Atlas Consolidated Mining & Development Corporation, Cebu, has completed arrangements, with approval by the Central Bank of the Philippines, for the construction of an acid and fertiliser plant near its Toledo copper mine. Equipment for the new plant is to be manufactured and installed by Saint Gobain, Chauny et Cirey Ltd., of France, at a cost of \$1,600,000. The total cost of the project will approach \$3½ million.

NORWAY

Oil refinery plan

A plan for building a major oil refinery in Norway has been submitted to the Norwegian Government by the Standard Oil Co. The refinery would have an output of about 2 million tons/year and would employ about 400 workers. It is envisaged that some of the oil would be exported to Denmark and Sweden. If the authorities approve the plan, the refinery would probably be built at Skjebergkilen on the east side of the Oslo Fjord, according to Norwegian press reports.

Full production at iron ore mines

A/S Syd Varanger, Norway's biggest iron-ore mines, situated near Kirkenes in the extreme north, are this year for the first time exploiting their production capacity 100%. The mines have been completely rebuilt after war-time destruction. Output of ore concentrate this year will probably reach 1 million tons, compared with 867,000 tons last year. West Germany is taking 570,000 tons, Britain 200,000 tons, and Austria 160,000 tons. The new Norwegian iron and steel plant at Mo i Rana, just south of the Arctic Circle, will take 125,000 tons.

INDIA

Plastic pipes plant for India?

The possibility of a factory to manufacture plastic pipes being set up in India was referred to recently by the Minister of Health, who said that firms from the U.S. might be interested in setting up such a factory.

The Minister, who recently returned from a tour of the U.S., said she was struck by the use made of plastic pipes there for sanitation and water supply. Stating that they were cheaper and as durable as, if not more so than, steel pipes, she said she had already taken up the matter with the Indian Ministry of Commerce and Industry.

Rather than importing the pipes, the Health Minister thought it would be more profitable if they were manu-

The Leonard Hill Technical Group—September

Articles appearing in some of our associate journals this month include:

Fibres—Heat Effects on Tensile Properties of Textiles; Vinyl Yarns and Fibres; Courtaulds Use-Development Organisation; MR3 Ring Spinning Frame; The World's Most Modern Thread Finishing Plant.

Building Materials—Tests for Building Materials: Some of the Problems; Oil-Fired Equipment for Space Heating.

Floors—Concrete Floor Finishes; Appropriate Timbers for Various Purposes.

Muck Shifter—The New Harbour at Shoreham; Developments in Dredging; Railway Construction in Uganda.

Food Manufacture—Sago Flour Dressing; Trace Elements in Foodstuffs, 3: Selenium; The Scalding of Vegetables Before Dehydration; Perishability of Foods in Consumer Packages; Substitute and Synthetic Foods; The Oils and Fats Industry Today.

Petroleum—Advances in Ethylene Production, 2; Hydrogen Attack on Mild-Steel Equipment, 2; Infra-Red Absorption Analysis in the Petroleum Refinery, 1; Recent Advances in Lubricating Oils, 1.

Corrosion Technology—The Cost of Corrosion; The Corrosion of Aluminium in Proximity with Iron; A Gaseous System of Corrosion Control; Russian Experience in Protecting Heat Exchangers from Aqueous Corrosion.

World Crops—The Latest Developments in Orchard Equipment; Solar Energy, 1; Improved USDA-34, A Better Sweet Corn for the Tropics; The Work of the Colonial Development Corporation.

factured in India. There are about 100 major plastic factories in India at present and the investment in the industry is about 70 million rupees. The second five-year plan (1956-61) provides 910 million rupees for urban and rural water supply and sanitation.

URUGUAY

Import authorisation

Uruguay has announced authorisation for the import of structural steel worth \$1,225,000 and pharmaceutical products worth \$1,400,000. Of this, the U.K., Germany and the Netherlands will supply structural steel worth \$480,000 and pharmaceutical products worth \$500,000.

MEXICO

Fertiliser factory

A new Mexican company with a capital of 62½ million pesos has been formed for the construction and exploitation of a large factory of nitro-

genous fertilisers at Monclova (Coahuila), Mexico, it has been announced.

According to a report from Paris, this new firm was formed following negotiations between the Mexican Nacional Financiera, the French chemical firm Saint Gobain, and one of the leading French nationalised banks, Banque Nationale pour le Commerce et l'Industrie, and the French import-export company, Compagnie Francaise Import-Export.

The new firm will be called Fertilizantes de Monclova, and the majority of shares will be held by public and private Mexican capital.

NETHERLANDS

Oil refining project

Some further details were given recently of the new refinery which the Standard Oil Co., of New Jersey, are to construct near Rotterdam on a site leased by their subsidiary, S.O. Nederland N.V. The new refinery will have an initial capacity of 1½ to 2 million tons p.a. and will cost more than 100 million florins.

Construction will start towards the end of 1957 at a site bordering the new third petroleum harbour below Rotterdam and the refinery is expected to begin operation early in 1960. A neighbouring site on the third petroleum harbour is being taken by Caltex Ltd. to build an extension of the small refinery which they already operate north of the River Maas and another small site is being leased to Dow Chemicals Ltd. for the construction of a petrochemicals plant using by-products of the new refineries.

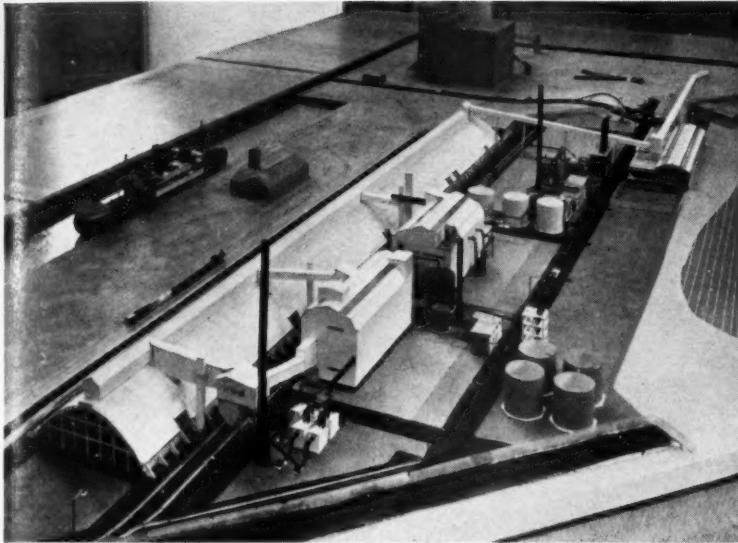
GREAT BRITAIN

Babcock & Wilcox and atomic energy

Babcock & Wilcox Ltd. have announced the formation, operative from October 2, of an atomic energy department. This department will be responsible, under the direction of the company's chief engineer, Mr. W. F. C. Schaap, for development, proposition and contract engineering in the atomic energy field. It will operate in close collaboration with the existing sales, engineering, commercial and manufacturing departments of the organisation.

Southern Gas Board to use surplus refinery gas

Surplus gas from the Esso Petroleum Co.'s refinery at Fawley, near Southampton, will be put to industrial and domestic use in the district as a result of a 10-year agreement concluded by the company with the Southern Gas



Scale model of a £3-million fertiliser works now being built by Scottish Agricultural Industries Ltd. at Leith, on the Firth of Forth, Scotland. The new factory will produce granular, concentrated compound fertilisers on a large scale, and a striking feature of the scheme is a store 907 ft. long, 100 ft. wide, and capable of holding 56,000 tons.

Board. By the agreement, a total of about 17 million therms p.a. of refinery gas will be supplied to the Board. This, after re-forming at Southampton, will give the equivalent of about 13 million therms of town's gas each year. The Board is to lay a 17-mile main from the refinery to Southampton works to take the supply.

As a result of the agreement the Board expects to save coal to the extent of 115,000 tons p.a., and there will also be savings in the consumption of gas oil and heavy oil.

It is hoped that the new main will be laid and other necessary work completed within the next twelve months, so that the Board can begin to take supplies of gas from the refinery during the summer of 1957.

New plant will manufacture pharmaceutical products

Construction began recently at Gosport, Hants., of a new 100,000-sq.ft. laboratory-type factory to be constructed by Cyanamid Products Ltd. at a cost of £700,000, for the production in Britain of Lederle pharmaceutical, nutritional and animal feed products, including the range of antibiotics derived from aureomycin. Construction is being undertaken by C.A.S. (Industrial Developments) Ltd. When completed, the new factory will employ some 300 people.

Speaking at the ground-breaking ceremony, Mr. K. C. Towe, president of American Cyanamid Co., said it

was hoped that the new plant would produce *Acronize*, which is now being used in the U.S. and other countries to reduce bacterial spoilage of poultry. Experiments are in progress, in Britain as well as in America, to apply *Acronize* to the preservation of meat and fish.

The Lederle Division of Cyanamid Products Ltd. has been operating in Britain since 1947, and construction of the new Gosport plant has been financed within the British company.

UNITED STATES

Boron trichloride production

The Stauffer Chemical Co. is planning to produce boron trichloride at Niagara Falls, N.Y. Until now, the firm states, this chemical, which is an essential raw material for the new boron high-energy fuels and missile propellants, has been available in only limited quantities.

When the new facilities are completed next February, it will be produced in substantial tonnage and shipped in tank-car quantities, the firm states. The plant will embody a process developed in Stauffer's laboratories, and will be the largest in the country for the production of this chemical.

New rubber compounds

Two new silicone-rubber compounds have been announced as having a tensile strength, tear strength and elongation properties more than

double those of the conventional types. The Connecticut Hard Rubber Co., of New Haven, Connecticut, which manufactures the products, said that they are flexible at high and low temperatures and are intended for moulded and extruded parts.

Grinding ball plant for Great Lakes

The National Malleable & Steel Castings Co. is to construct a \$10-million grinding ball plant at the head of the Great Lakes near the large taconite, iron ore and copper ore processing plants.

Grinding balls are used to pulverise iron ore so that it can be converted into taconite pellets.

Construction of new industrial plants

Scientific Design Co. Inc., which specialises in the design and engineering of chemical manufacturing plants, has formed a wholly-owned subsidiary for the construction of industrial plants in the chemical field.

The title of the new firm is S.D. Plants Inc., and it will shortly complete its first two major projects: a polyvinyl chloride plant in Passaic, New Jersey, for the Eleonora Chemical Corporation, a subsidiary of the Pantasote Co., and a polyvinyl chloride plant in Leominster, Massachusetts, for the Chemical Division of the Borden Co. Both plants are scheduled to begin operation this summer.

Titanium dioxide plant expansion

The Glidden Co. has announced that it is accelerating its plans for a \$30-million addition to its Adrian Joyce titanium dioxide plant in Baltimore, quadrupling its capacity. The company said the addition, originally scheduled for completion by 1960, would be made next year.

Magnesium-thorium alloy

The Dow Chemical Co. has developed a new magnesium-thorium alloy that can be used in high-temperature aircraft development projects. The company says that the alloy, which is now deliverable in production quantities, is the first of a series of magnesium alloys containing thorium, zirconium and manganese for high-temperature work.

The new alloy has excellent corrosion resistance, it is stated, and, because of its light weight, it can be used in thicker sections than heavier metals.

Heavy chemicals project

To broaden the scope of its operations in Latin America, Pennsalt Chemicals plans early construction of

its third plant in Mexico. The new component will be known as Industrial Quimica Pennsalt S.A. de C.V. and will operate in conjunction with Pennsalt International Corporation.

The new installation, located near the company's agricultural chemicals plant in Mexico City, will produce chlorine, caustic soda, muriatic acid and hydrogen, and is expected to

become the first in Mexico to manufacture technical DDT.

Other Pennsalt interests in Mexico are fluorspar mining operations at San Luis Potosi and a new agricultural chemicals processing plant nearing completion at Navojoa, Sonora, in north-western Mexico. The company also has plants and sales offices in Brazil, Peru and Venezuela.

important investigations concerning the application of atomic energy to power generation. **Mr. W. R. Wootton** has been appointed assistant manager of the department. As one of the company's senior engineers, he has been closely associated with the Atomic Energy Authority in feasibility studies and in atomic developments, which included the proposition and design of the specialised steam-generating plant that has been manufactured by Babcock & Wilcox Ltd. for the first full-scale atomic power station at Calder Hall. The position of chief research engineer, vacated by Mr. T. B. Webb, will be filled by the appointment of **Dr. W. B. Carlson**, at present assistant to Mr. Webb.

★ The managers and staff of G. A. Harvey & Co. (London) Ltd. recently made a presentation to **Mr. H. W. H. Icough** on his retirement. He joined the company in 1907 and was in charge of the zinc and ironwork departments during the first world war. He was appointed a departmental manager in 1919 and for many years has been solely responsible for the working of the wirework and wire weaving departments.

★ **Mr. W. A. Coates** has retired from the board of Metropolitan-Vickers Electrical Co. Ltd. He will continue as commercial consultant to the managing director until the end of the year. Mr. Coates has been with companies of the A.E.I. Group for a total of 50 years. He joined M.-V. (then British Westinghouse) in 1909 and was successively chief engineer (1918) consulting engineer, and sales manager in the switchgear department before becoming manager, home sales, in 1946. In 1948 he was appointed to the board and, from 1952 till early last year, he was general sales manager. Mr. Coates has also resigned from the boards of the following M.-V. subsidiary companies: Metropolitan-Vickers—G.R.S. Ltd., Newton Victor Ltd., and Sunvic Controls Ltd.

Asbestos Fibres in Gaskets

(Concluded from page 321)

Apart from the disadvantages of separation and cleaning, joints which stick to both faces often provide the most satisfactory seal. In any case, where joints are to be replaced, a new joint should always be used, the flanges first being scraped clean and free from any old material.

It is important to remember that on hot applications good practice calls for retightening of the bolts holding the flanges together after the joints have reached the working temperature.

★ Personal Paragraphs ★

★ To meet the organisational requirements of the development programme of Monsanto Chemicals Ltd., the following appointments have recently taken effect: **Mr. W. M. Thompson**, director of purchases, is now sales director; **Mr. J. S. Brough**, chief engineer, becomes general manager of production; **Mr. J. S. Hunter**, sales controller, becomes general manager of development; **Mr. W. E. Hamer**, manager of research department, becomes general research manager; **Mr. J. M. Kershaw**, project manager, becomes chief engineer; **Mr. D. C. M. Salt**, sales controller, becomes general manager of sales; **Mr. G. Dodd**, director and general manager of Monsanto Plastics Ltd., becomes controller of purchases, Monsanto Chemicals Ltd. **Mr. E. L. Pixton**, sales controller of Monsanto Chemicals Ltd., and a director of Monsanto Plastics Ltd., will, until further notice, devote the whole of his time to promoting the marketing interests of Monsanto Plastics Ltd. The appointment is also announced of **Mr. O. W. Murray**, chief construction engineer, to be deputy chief engineer.

★ The directors of G. & J. Weir Ltd., Cathcart, Glasgow, announce the appointment to the executive board of **Mr. Andrew C. Smith**. He was appointed manager of Weir's London office in January 1948, and will now return to the head office in Glasgow as sales director.

★ **Mr. E. R. Brown** has been appointed chief planning engineer of Quickfit & Quartz Ltd., manufacturers of interchangeable laboratory glassware of Stone (Staffs). He succeeds **Mr. S. Cliss**. Before joining Quickfit & Quartz, Mr. Brown was employed on similar duties in the pottery industry and earlier by a light-engineering firm in Stafford.

★ **Mr. D. A. Kressin** has been appointed European sales representative of the American company, Eastman Chemical Products Inc., subsidiary of Eastman Kodak Co. Eastman are establishing their own sales

headquarters in The Hague, Netherlands, and Mr. Kressin will supervise the company's sales of chemical raw materials in all countries outside the Soviet sphere.

★ **Mr. E. T. Gill**, B.Sc., F.I.M., has recently joined the staff of the development and research department of the Mond Nickel Co. Ltd. as development officer for constructional alloy steels. He is taking up the position which became vacant when **Mr. L. W. Johnson** was appointed assistant manager of the department.

★ **Mr. G. A. Dummett** has been elected to the board of directors of the A.P.V. Co. Ltd. He joined the company in 1935 and has successively been laboratory manager and scientific manager responsible for the research and development organisation of the company.

★ **Mr. T. B. Webb** has been appointed chief engineer and manager of the atomic energy department of Babcock & Wilcox Ltd., the formation of which is reported on another page. As chief research engineer, he has for some years directed the activities of the company's large research department centred at Renfrew, including



Mr. G. A. Dummett.

